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14. ABSTRACT

The primary goal of the Defense Acquisition Review Journal (ARJ) is to provide practicing DoD Acquisition, Technology and Logistic Professionals with relevant management tools and information based on recent advances in policy, management theory, and research. The ARJ addresses the needs of professionals across the full spectrum of defense acquisition, and is intended to serve as a mechanism for fostering and diseminating scholarly research on acquisition issues, for exchanging opinions, for communicating policy decision, and for maintaining a high level of awareness regarding acquisition management philosophies.

15. SUBJECT TERMS

Evaluating the Impact of Electronic Business Systems Lessons Learned rom Three CAses at the Defense Logisitics Agency, How Compensation in Test and Evaluation Affects Aircraft Acquisition System, An Initial Look at Technology and Institutions on Defense Industry Consolidation, Surveying Cost Growth.

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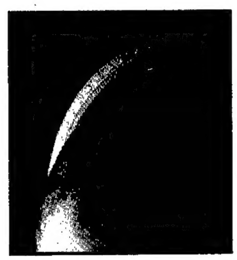
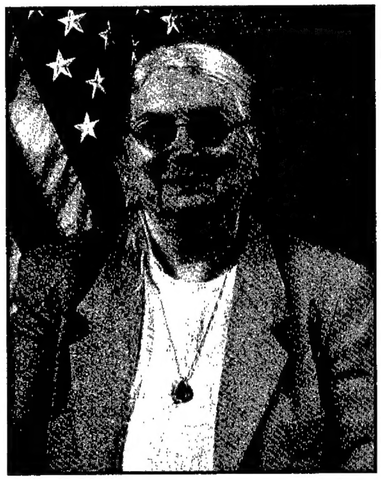


enhance weapon system support by employing best commercial practices in providing an integrated and performance-based supply chain, they often do not combine the best of government support with commercial support. This results in dual infrastructures, increased costs, and other disadvantages. This article addresses the advantages of combining public and private support by discussing lessons learned from two PBLs where the Defense Logistics Agency has become the source of supply to commercial vendors awarded PBL contracts by the Military Services.

TUTORIAL



DEFENSE ARJ EXECUTIVE EDITOR

First I would like to thank every one of our readers for the overwhelming response to our first theme edition published in August of this year. Due to the tremendous feedback, we feel we are on the right track in providing more focused editions and are looking forward to continuing to produce theme editions in the future. Currently planned are publications focused on Communities of Practice (CoP) and system-of-systems acquisition. Anticipated future editions will feature articles on Transformation and Leadership, Systems Engineering Best and Worst Practices, and Technology Transition and Implications. If you are doing research in any of these areas and would like to submit an article, please contact Norene Taylor, managing editor, *Defense ARJ,* at norene.taylor@dau.mil. Similarly, if you are interested in being an article reviewer in any of these areas, we would like to hear from you. We welcome your participation in helping us to ensure this journal meets the needs of the Acquisition, Technology, and Logistics (AT&L) workforce.

The thrust of this edition is Performance-Based Acquisition, and as many of you know, the emphasis on *performance* within the government began in 1992 with the passage of the Government Performance and Results Act. It was further emphasized by former Vice President Al Gore in his National Performance Review and also in subsequent Hammer Award presentaions. Today of course, we accept performance as a focus for all acquisition disciplines and processes. Consequently, the articles presented in this edition, touch on various areas of the acquisition process and ways in which performance is affecting the things we *do* and the way we *think.*

Our featured author, Dr. Hank DeVries, is an instructor at the Defense Acquisition University (DAU) West Region and is interested in ways in which Performance-Based Logistics (PBL) is being implemented. His research article entitled, "Performance-Based Logistics–Barriers and Enablers to Effective Implementation," considers the practical aspects of PBL and identifies those items within this practice that can lead to a successful endeavor and those barriers that can confound and seriously effect its successful implementation.

The following three articles document other applied *research* activities. Berkowitz, Gupta, Simpson, and McWilliams in their paper, "Defining and Implementing Performance-Based Logistics in Government," provide a working definition of PBL and address the infrastructure changes needed for its successful deployment. Mahafza, Componation, and Tippett's, "A Performance-Based Technology Assessment Methodology to Support DoD Acquisition," focuses on the topic of *performance risk* and

suggests the use of a Technology Performance Risk Index (TPRI) as a means of tracking technology readiness. Gaines and Michael's article entitled, "Managing Acquisition of Software-Intensive Systems with Service Level Agreements," provide a prescriptive approach to managing in a performance-based environment.

The next article focuses on *lessons learned* to assist future performance-based acquisition efforts. Starks paper entitled, "Public and Private Partnerships in Supporting Performance-Based Logistics Initiatives," focuses on lessons learned from combining the best of government support with commercial support for providing an integrated, performance-based supply chain.

Our last three articles are *tutorials* regarding the implementation of performance-based efforts. Friar's, "Performance-Based Service Acquisition (PBSA), A-76 and Personal Services," discusses the issue of personal services in a performance-based arena. Cavadias' paper entitled, "Contract Administration in a Performance-Based Acquisition Environment is Serious Business," looks at ways in which to conduct contract administration in a performance-based environment. Finally, Barnette's "Test and Evaluation in a Dynamic Acquisition Environment," talks about the incorporation of new test and evaluation procedures to reduce risk and ensure performance expectations.

Therefore, we have provided you with a wide range of articles on the topic of performance-based acquisition. As a follow-on activity to our Journal, we will be conducting a discussion forum in January based on this edition using the authors as discussion leads. Please look for our advertisements toward the end of this journal. We hope that you are interested enough in the topic of Performance-Based Acquisition to join us or to provide questions for discussion. We intend to use the Acquisition Research Community of Practice interest area on the Acquisition Community Connection as a vehicle for sharing discussion information.

Dr. Beryl A. Harman
Executive Editor
Defense ARJ

DECEMBER **2004** – MARCH **2005**

PERFORMANCE-BASED LOGISTICS— BARRIERS AND ENABLERS TO EFFECTIVE IMPLEMENTATION

DR. HANK J. DEVRIES

The Department of Defense is implementing Performance-Based Logistics (PBL) in both new acquisition programs and legacy programs. Each of the Services is executing PBL policy at the system, subsystem, and component level. The Services are also working in conjunction with each other to implement PBL on joint programs. This study identifies the most common barriers and enablers as the Services go forward with PBL implementation, determines if there are relationships between these barriers and enablers, and also evaluates the success of PBL implementation.

Traditionally, support for weapon systems in the Department of Defense (DoD) centered around ten or eleven logistics elements, split between acquisition-related activities at the front end of the life cycle- and sustainment-related activities at the back end. Metrics focused on the logistics elements themselves and internal processes often having little direct relationship to warfighter requirements. The shift toward Integrated Logistics Support attempted to wrap together the distinct logistics elements into a coordinated approach, but there was still the disjointed acquisition versus sustainment-support issue and the lack of a linkage between supportability measures and warfighter needs. In addition, choice of support providers was often an *all or nothing* proposition; either entirely organic (DoD) or entirely commercial (CLS or contractor logistics support). The advent of Total Life Cycle Systems Management (TLCSM) and Performance-based Logistics (PBL) addressed all of these issues.

The TLCSM mandated a new focus by program managers toward the entire life cycle, firmly linking acquisition and sustainment activities into an integrated process. To measure success, PBL required that supportability metrics be directly related to performance outcomes for the warfighter, and PBL also offered a choice of organic and commercial support providers for picking the right combination in achieving best value to the program. A succinct definition quoted from a recent report by the Center for the Management of Science and Technology at the University of Alabama in Huntsville defines PBL as, "an integrated acquisition and sustainment strategy for enhancing weapon system capability and readiness, where the contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers, both organic and non-organic, to support the end user's (warfighter's) objectives" (Berkowitz, et al., 2003, p. 5).

The TLCSM mandated a new focus by program managers toward the entire life cycle, firmly linking acquisition and sustainment activities into an integrated process.

Implementation of PBL was mandated in September, 2001 in the Quadrennial Defense Review (QDR), and initial guidance was promulgated by the Office of Secretary of Defense (OSD) (Aldridge, 2002). The OSD issued a Product Support Guide that provided a strategy for executing PBL (Morales, 2001). Subsequently, each of the Services provided implementation guidance to their programs (Bolton, 2002; Schneider, 2002). In accordance with the FY03 Defense Policy Guidance, the scope of the programs to be considered for PBL implementation included all new weapon systems and all Acquisition Category (ACAT) I and II fielded systems (Young, 2003). The importance of sustainment in the program life cycle and in implementing PBL was recognized. To ensure the requisite priority on sustainment issues within program offices and to ease the PBL implementation efforts, the concept of TLCSM was promulgated (Aldridge, 2003).

Total Life Cycle Systems Management emphasizes an early focus on sustainment in the program management office, making the program manager responsible for all activities associated with the acquisition, development, production, fielding, sustainment, and disposal of a weapon system across its life cycle. This was a significant paradigm shift from traditional program management focus on the early phases (acquisition, development, fielding) of the life cycle. To support the decision-making process in selecting organic and commercial support providers, OSD promulgated guidelines for conducting a Business Case Analysis (BCA) (Wynne, 2004a). In addressing the performance metrics' relationship to

desired outcomes, OSD provided some common examples such as operational availability and logistics footprint (Wynne, 2004b).

The Services began encountering problems in implementing PBL, both for new and existing programs. There were existing cultural and structural barriers that inhibited effective implementation. On the other hand, there were a number of enablers that were being utilized for more effective implementation. These barriers and enablers were the subject of numerous program briefings and reports presented at a number of conferences and road shows over the last couple of years.

This research study intends to identify the most frequently impacting barriers and enablers to effective PBL implementation within DoD, how they influence PBL implementation, and recommend strategy/actions that will facilitate more effective implementation for new and legacy programs.

LITERATURE REVIEW

An extensive search was conducted on the Internet to identify current PBL policy and implementation guidelines. A review of OSD and Service Web sites, as well as some industry Web sites, was completed. Briefings from a number of conferences were obtained, showing the status of several programs undergoing PBL implementation. Also, there were ongoing discussions and correspondence regarding PBL implementation and problems encountered with a number of practitioners within the Services. A review was conducted of existing DAU curriculum in Performance-Based Acquisition and Performance-Based Logistics. Through participation in PBL conferences and road shows, there were discussions with key policymakers and implementers. Based on the preliminary literature survey and feedback from practitioners, it was apparent that there were numerous instances of misunderstanding of the PBL concept, resistance to its initiatives, and problems in implementation.

RESEARCH QUESTIONS AND HYPOTHESES

The following questions were posed to frame the research effort:

1. What are the barriers and how do they influence PBL implementation?
2. What are the enablers and how do they influence PBL implementation?
3. What strategy/actions would lead to more successful PBL implementation?

In reference to question 1, seven key barriers were identified through the efforts of the Literature Review. These barriers were:

1. Funding restrictions/inflexibility (e.g., Working Capital Fund, various appropriations/transfer and expiring funds rules, limited Program Manager [PM] control over Operation and Maintenance [O&M]).

2. Statutory/regulatory requirements (e.g., Title 10, service policies).

3. Old paradigms/culture (e.g., organic versus commercial, parts management versus performance management, minimize contractors on the battlefield).

4. Existing infrastructure/bureaucracy (e.g., PM office structure, stovepiping, short PM tours).

5. Technical data rights issues.

6. Lack of PBL awareness/training.

7. Inability to incentivize organic providers.

In reference to question 2, seven key enablers were identified through the efforts of the Literature Review. These were:

1. Supply Chain Management (e.g., end-to-end customer support, enterprise integration).

2. Strategic alliances/partnerships (e.g., depot partnering, joint ventures).

3. Performance-based contracting (e.g., incentivizing performance).

4. Performance-based metrics.

5. Total Life Cycle Systems Management (TLCSM) perspective.

6. Adoption of Commercial Off-the-Shelf (COTS)/Best Commercial Practices.

7. Reduction in Total Ownership Cost (RTOC) initiative.

Based on the research questions, six hypotheses were developed:

1. There is an indirect relationship between the number of barriers and the success of PBL implementation.

2. There is a direct relationship between the mitigation of barriers and the success of PBL implementation.

3. There is an indirect relationship between the influence of barriers (after mitigation) and the success of PBL implementation.

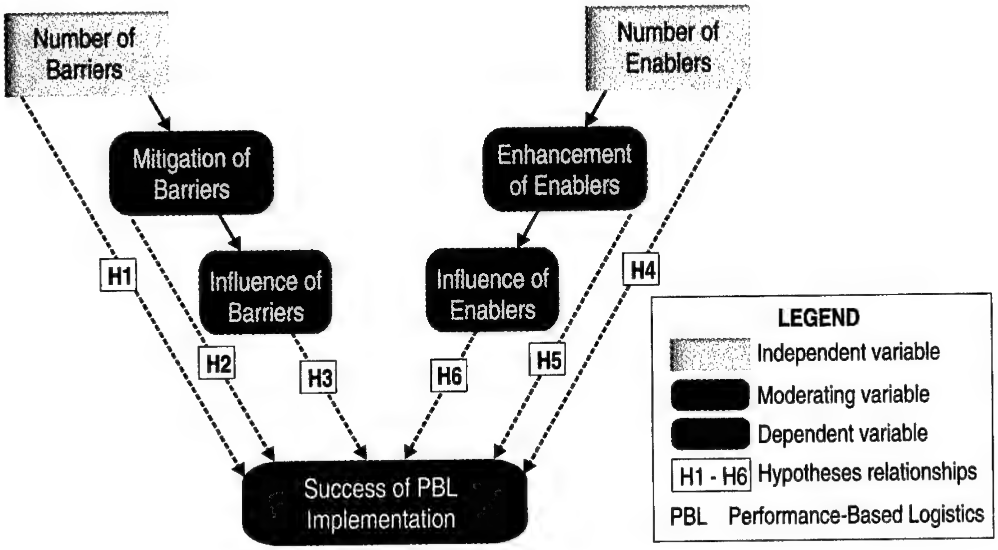


FIGURE 1. RESEARCH MODEL

4. There is a direct relationship between the number of enablers and the success of PBL implementation.

5. There is a direct relationship between the enhancement of enablers and the success of PBL implementation.

6. There is a direct relationship between the influence of enablers (after enhancement) and the success of PBL implementation.

The research model in Figure 1 graphically displays these hypotheses and associated variables.

RESEARCH METHODOLOGY

This research study was primarily qualitative in the measurement of variables. Correlational research was conducted using surveys to obtain primary data. Surveys were selected as an effective method to obtain data from program offices where they are implementing PBL in their programs. The statistical test used for all six correlation hypotheses was the Pearson product-moment (at least one of two variables in each hypothesis is ratio or interval type data). Due to the small size of the sample and the fact that the dependent variable consisted of ordinal type date, the Spearman rank-order r test was also conducted on all six hypotheses. Results were then com-

pared with the results of the Pearson product-moment test. No significant differences were noted.

RESEARCH SURVEY

A data survey was created on the Web and instructions sent out to key PBL points of contact (POC) within each of the Services. The Service POC's instructed program managers that had undergone PBL implementation within their respective Service to fill out the data survey. There were a total of 26 program managers that responded to the survey. Of the 26 programs, 10 were Joint, 9 were Army, and 7 were Navy/Marine Corps. No Air Force specific programs responded. Both new and legacy programs participated. Of the 26 programs, 11 were new and 15 were legacy. Another distinguishing factor was the scope of the PBL; implemented at the system, subsystem, or component level. Of the 26 programs, 11 were system level, 9 at subsystem level, 4 at component level, and 2 did not distinguish. A final distinguishing factor was the impact of PBL on logistics elements. Three primary logistics elements were chosen: supply, maintenance, and transportation. Of the 26 programs, 13 impacted all three elements, 4 impacted supply and maintenance, 1 impacted supply and transportation, 2 impacted only supply, 3 impacted only maintenance, 1 impacted only transportation, and 2 did not distinguish. Figure 2 provides a summary chart.

RESEARCH FINDINGS

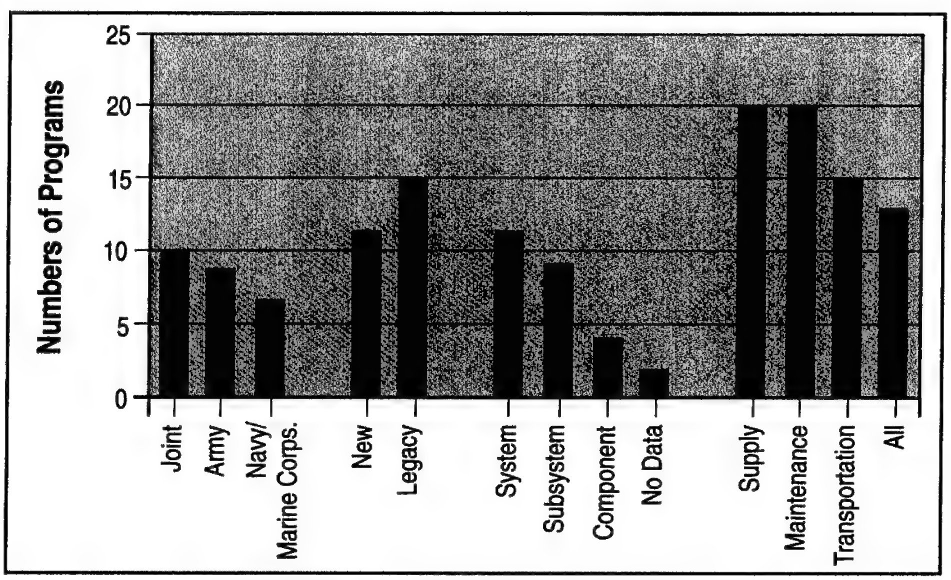


FIGURE 2. PROGRAM SUMMARY CHART

Of the 26 programs surveyed, 17 identified funding as a barrier; 13 identified statutory/regulatory, culture, and lack of PBL training as barriers; 12 identified existing infrastructure as a barrier; 11 identified technical data rights issues as a barrier; and

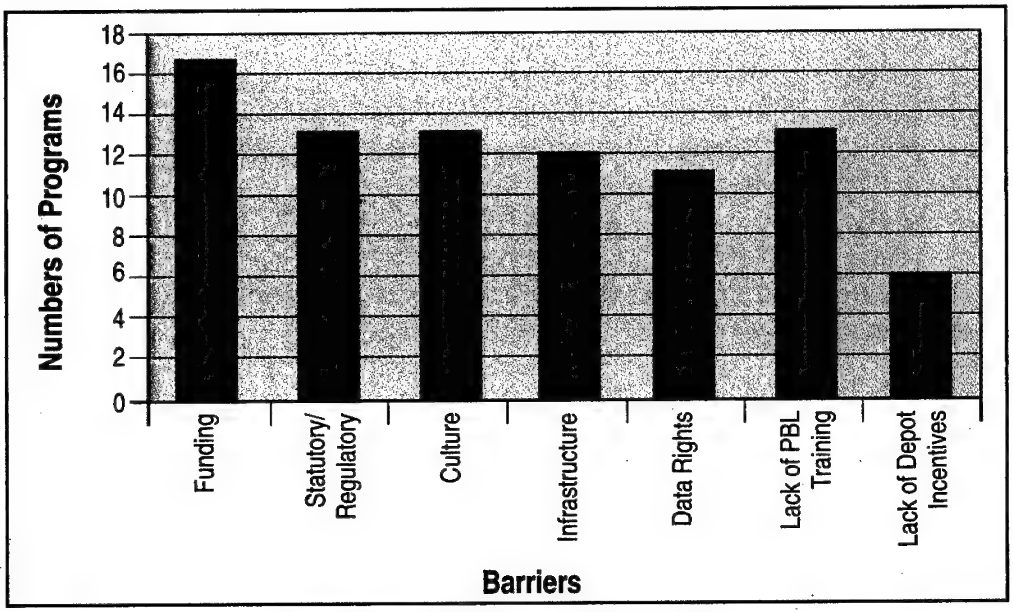


FIGURE 3. BARRIERS IDENTIFIED

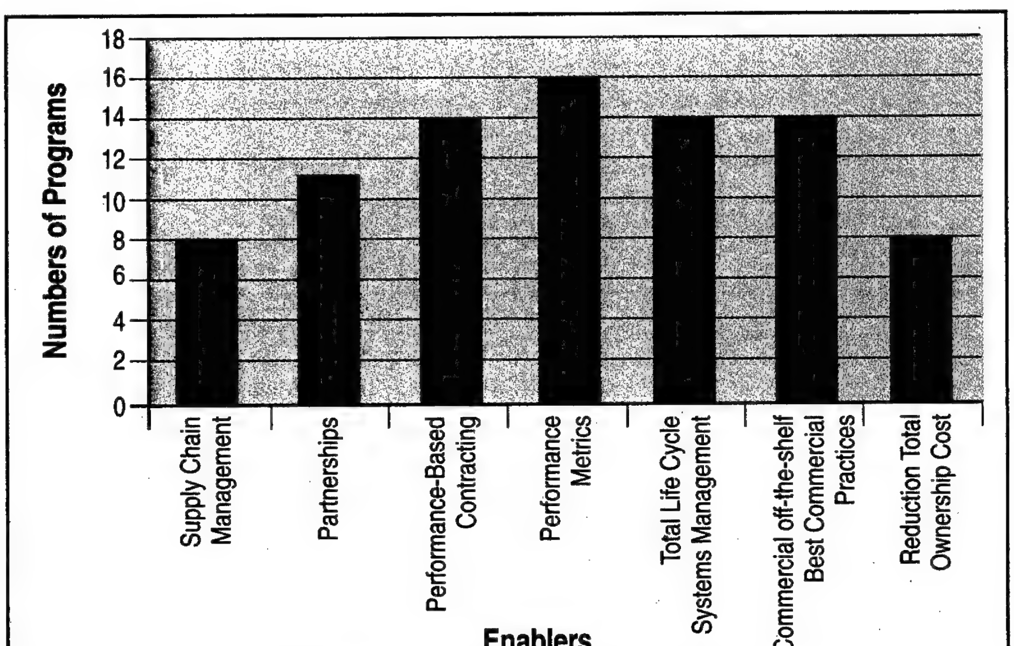


FIGURE 4. ENABLERS IDENTIFIED

6 identified lack of organic depot incentives as a barrier. For the same 26 programs surveyed, 16 identified performance metrics as an enabler; 14 identified performance-based contracting, TLCSM, and COTS/best commercial practices as enablers; 11 identified partnering as an enabler; and 8 identified supply chain management and RTOC as enablers. Summary charts of the results are shown in Figures 3 and 4.

Of the 6 hypotheses tested, the data analysis supported 3 hypotheses at the 0.10 significance level using both the Pearson product-moment test and the Spearman rank-order r test. Of the 3 supported hypotheses, 2 were supported at the 0.05 significance level using the Pearson product-moment test and 1 was supported at the 0.05 significance level using the Speaman rank-order r test. The 3 supported hypotheses were:

1. There is a direct relationship between the number of enablers and the success of PBL implementation.

2. There is a direct relationship between the enhancement of enablers and the success of PBL implementation.

3. There is a direct relationship between the influence of enablers (after enhancement) and the success of PBL implementation.

TABLE 1.
RESULTS SUMMARY

Hypothesis	Pearson Correlation Coefficient	Significance Level (Pearson)	Spearman Correlation Coefficient	Significance Level (Spearman)
Indirect relationship between number of barriers and success of Performance-Based Logistics (PBL).	-0.102	0.68	-0.154	0.53
Direct relationship between mitigation of barriers and success of PBL.	-0.162	0.51	-0.130	0.60
Indirect relationship between influence of barriers (after mitigation) and success of PBL.	-0.192	0.43	-0.227	0.35
Direct relationship between number of enablers and success of PBL.	0.414	0.08	-0.443	0.06
Direct relationship between enhancement of enablers and success of PBL.	0.540	0.02	0.456	0.05
Direct relationship between influence of enablers (after enhancement) and success of PBL.	0.533	0.02	0.393	0.10

Of the 6 hypotheses tested, the data analysis did not provide sufficient support for 3 of the hypotheses. They are as follows:

1. There is an indirect relationship between the number of barriers and the success of PBL implementation.

2. There is a direct relationship between the mitigation of barriers and the success of PBL implementation.

3. There is an indirect relationship between the influence of barriers (after mitigation) and the success of PBL implementation.

A summary of the results is shown in Table 1.

CONCLUSIONS

Based on the results of the survey and data analysis, there appears to be some relationship between the identified enablers and the success of PBL implementation. The most frequent enablers that appeared to influence success were performance metrics, performance-based contracting, TLCSM, and COTS/Best Commercial Practices. This is in alignment with the level of emphasis in these areas from both a policy and training perspective within DoD. Those enablers influencing fewer programs were supply chain management and RTOC. Although certainly important from a broad PBL perspective, it may be more challenging for respondents to link these concepts to PBL execution at the program office level.

As in most research studies, all the hypotheses may not be supported from the data analysis. In this case, the hypotheses dealing with barriers to PBL implementation and their influence on success were not supported at the requisite significance level. This may be due to the small sample size (26) and/or the inability to understand the true impacts of barriers on PBL execution. It was apparent in the literature survey that a number of activities view barriers as a significant issue in their implementation efforts and that policymakers are coming out with initiatives to mitigate some of those barriers. What the research study did show was that funding seems to be the most frequently encountered barrier followed by statutory/regulatory, culture, and lack of PBL training. The least encountered barrier was lack of organic depot incentives, which may be partly due to the use of commercial depots by some of the programs surveyed.

SUMMARY/RECOMMENDATIONS

Based on the research study findings, policymakers in DoD should continue to focus on initiatives that encourage the use of enablers such as performance metrics, performance-based contracting, and use of COTS/Best Commercial Practices. They should look at ways to more closely link concepts such as Supply Chain Management

and RTOC to program execution so that implementers of PBL realize the practical application of those concepts. Policymakers should increase their efforts to mitigate barriers in the funding, statutory/regulatory, and training areas. Replacement of the Planning, Programming, and Budgeting System (PPBS) with Planning, Programming, Budgeting, and Execution (PPBE) and relaxation of regulatory requirements (DoD 5000 series/Defense Acquisition Guidebook) are starting to have some impact, along with a new focus on Performance-Based Acquisition training at the Defense Acquisition University through classroom, online, and continuous learning activities. These efforts need to continue and be reinforced by service policy and training efforts.

At the program office level, logisticians need to work in close concert with the program manager and other acquisition disciplines to address performance issues and ensure metrics are linked closely with warfighter outcomes. Contracting officers need to work closely with logisticians when drafting contracting strategy and building incentives into contracts. Financial managers and logisticians need to jointly develop life cycle cost estimates and come up with innovative approaches within the funding constraints and statutory guidelines to reduce total ownership cost. Logisticians need to develop objective business case analyses to support smart decisions on the right mix of support providers to optimize warfighter performance outcomes.

In summary, PBL along with TLCSM have required a paradigm shift in how we view program life cycles and supportability. There are a lot of challenges or barriers that inhibit our ability to be effective. There are also a lot of enablers that increase our ability to be successful in implementing PBL. If policymakers working in concert with program offices can continue to mitigate the barriers and enhance the enablers, we can offer a better product to the warfighter that will meet or exceed their performance requirements while providing long term savings to the program. Only in this way can we both meet the increasing challenges of the new threat environment and stay within the tightening budget constraints of today and in the future.

Dr. Hank DeVries is currently serving as the Associate Dean for Outreach and Performance Support at the Defense Acquisition University, West Region, San Diego, CA. He is a Certified Professional Logistician and has more than 26 years experience in acquisition and sustainment logistics. He earned a master of science degree in material logistics support management from the Naval Postgraduate School, and a doctor of business administration degree in strategic management from Alliant International University. Dr. DeVries is a member of the Defense Acquisition Corps and is certified at DAWIA Level III in Acquisition Logistics and Program Management. In addition to his work as the Associate Dean, he also teaches acquisition management, logistics, and program management courses for the Defense Acquisition University.

(E-mail address: hank.devries@dau.mil)

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DEFINING AND IMPLEMENTING PERFORMANCE-BASED LOGISTICS IN GOVERNMENT

DR. DAVID BERKOWITZ, DR. JATINDER N. D. GUPTA, DR. JAMES T. SIMPSON, AND JOAN B. MCWILLIAMS

Performance-Based Logistics (PBL) is a mechanism to integrate the acquisition and sustainment of various systems in the Department of Defense. In this article, we report the results of a research study aimed at developing a working definition of PBL, the drivers for its use, and the infrastructure changes needed for its successful deployment. Utilizing our research findings and those of previous related studies, we suggest guidelines for successfully implementing PBL in organizations. We conclude the article by suggesting some useful directions for future research to fully realize the benefits of PBL.

Product acquisition and sustainment have traditionally been separate and not necessarily equal concerns. The government's primary focus has been on the acquisition of technology and systems. Additionally, the government has had a number of secondary concerns: sustainment of the system, technology transfer, and the development of an industrial base to support the system long term. The environment for government acquisition creates consequences for major programs that span years, if not decades. As the government strives to understand how to generate the best value for its systems, it is appropriate to study experiences in the Department of Defense (DoD) and in Industry in order to maximize performance for the life of the system.

The ultimate goal in an acquisition strategy is to build both partnerships and relationships that align the goals of all organizations for the duration of the program. Once the competition for the initial acquisition of a system has occurred, the ability of the government and the contractor to make substantial changes in the system is typically limited. Since some acquisition efforts last for decades, it is essential for the parties to explore the acquisition strategy carefully before embarking on a course of action. This is especially so as, over the life cycle of most systems, it has been estimated that about 30 percent of all dollars spent are used to acquire the system, while the remaining 70 percent of all dollars are used for support.

The goal of both acquisition and sustainment is to gain the most efficient and effective performance of the system for its entire life. In doing so, it is important to realize that acquisition and sustainment are not separate but simultaneous and integrative issues that require analysis and synthesis throughout the product life cycle. Ultimately, the challenge for the program manager is to structure optimal relationships with contractors through the use of appropriate contractual mechanisms, agreements, and incentives.

The Department of Defense initiated a long-term program to link performance to acquisition through a concept called *Performance-Based Logistics (PBL),* which represents an integrated Perfomance-Based Environment (PBE) for both acquisition and sustainment. This is very appropriate since dollars spent on maintenance continue to increase as systems age. Since the inception of PBL, various agencies have tried to develop definitions, implementation guidelines, and infrastructure to attain the goal of acquisition and sustainment integration through performance-based initiatives. While several organizations in various branches of the DoD have attempted to use PBL approaches in acquisition and sustainment efforts, no clear and universally acceptable definition of PBL exists. Therefore, there is no clear understanding of the drivers of PBL. Hence, implementation guidelines for PBL are at best ad-hoc and incomplete. This situation undermines the DoD's ability to use PBL to make Defense operations more responsive.

The purpose of this article is to identify the issues and complexities of the relationships that exist in making the transition to the PBL environment. Utilizing the relational exchange theory and new product development literature, along with the combined knowledge and resources of the government and in Industry, we develop a conceptual and working definition of PBL, identify the drivers for the deployment of PBL, propose the needed infrastructure changes to be effective and efficient in using PBL, and outline guidelines found useful in implementing PBL. Finally, we conclude the paper by summarizing our findings and suggesting some directions for future research to successfully implement PBL.

RESEARCH PROCESS

In this section, we briefly describe the combination of research processes and methodologies used to achieve the goals of this research. Basically, we used interviews as the primary vehicle to gather information about the definition and deployment of PBL. In addition to interviews, we hosted roundtable discussions. We also participated

in an Army Materiel Command (AMC)-wide PBL video conference at the Aviation and Missile Command (AMCOM). For the interviews, we used an emergent design process that employs a predetermined set of questions to start the interview process. In this approach, the set of questions are altered over time to reflect what was learned in previous interviews. Before the interview process began, each respondent was informed that the purpose of the research was to develop a workable definition and implementation approach for the transition to a PBL environment.

While a DoD-wide study of PBL efforts is useful, information is also available from the Industry's logistics strategies and approaches to solving problems.

Following a review of the PBL literature, we identified individuals and organizations engaged in PBL-type activities. We then grouped potential respondents into four categories: Army, Navy, Air Force, and Industry. We conducted in-depth interviews, often lasting many hours, with contractors and DoD project managers. For example, interviews were conducted at Warner Robins Air Force Base, Wright Patterson Air Force Base, Naval Inventory Control Point (NAVICP) in Philadelphia, and at PBL Conferences. We used each interview to document and investigate how PBL is both defined and operationalized. In some instances, we also conducted telephone interviews including those with people from Headquarters (HQ) Navy, General Accounting Office (GAO), Defense Logistics Agency (DLA), RAND, and selected contractors. In general, there was a very high level of cooperation at all levels among both government and Industry participants.

RESPONDENTS

A review of literature on PBL-related activities revealed that, in 1998, DoD established 30 sustainment pilot programs, of which 24 adopted some type of innovative product support strategies (Product Support for the 21st Century, 2001). We contacted project managers from the pilots to schedule visits and interviews. Table 1 lists the 30 initial programs and highlights the programs interviewed by our research team.

In addition to the pilot programs listed in Table 1, we also interviewed managers from the Soldier Focused Logistics (SFL) program, a collaborative effort between AMCOM and the Cargo Helicopters Project Manager's (PM) Office to support the CH-47 fleet sustainment using PBL strategies.

TABLE 1.
PILOT PROGRAMS FOR PRODUCT SUPPORT STRATEGIES

DoD PILOTS FOR PRODUCT SUPPORT STRATEGIES		
Abrams M-1 Tank	Advanced Amphibious Assault Vehicle (AAAV)	Airborne Warning and Control System (AWACS)
Advanced Field Artillery Tactical Data System (AFATDA)	AEGIS Cruiser	**B-1B Lancer**
Apache AH-64	**ASE/CASS**	**C-17 Globemaster**
Chinook CH-47	Common Ship	**C-5 Galaxy**
Comanche RAH-66	CVN-68	Cheyenne Mountain Complex
Crusader	**EA-6B Prowler**	F-117 Nighthawk
Guardrail/Common Sensor	**H-60 Helicopter**	F-16 Falcon
Heavy Expanded Mobility Tactical Trucks (HEMTT)	Landing Platform Dock-17 (LPD-17)	**Joint Surveillance Target Attack Radar System (J-STARS)**
High Mobility Artillery Rocket System (HIMARS)	Medium Tactical Vehicle Replacement (MTVR)	**KC-135 Stratotanker**
TOW/ITAS	**Standoff Land Attack Missile-Expanded Response (SLAM-ER)**	Space-Based Infrared Systems (SBIRS)
ASE/CASS = Aviation Support Equipment Consolidated Automated Support System TOW/ITAS = Tube-launched, Optically-tracked, Wire-guided Improved Target Acquisition System		
Highlighted programs were included in our Performance-Based Logistics research through interviews or presentations.		

While a DoD-wide study of PBL efforts is useful, information is also available from the Industry's logistics strategies and approaches to solving problems. Therefore, we interviewed Industry managers from AutoZone, UPS, Target, Caterpillar, Intergraph, Dell Computers, Royal Caribbean Cruises, and the University of Toronto. Since the term *Performance-based Logistics* is not used in the private sector, we widened the scope of logistics to include inventory management, spare parts acquisitions and repair, and maintenance activities.

DEFINITION OF PBL

The first objective of our research was to review existing definitions of PBL used in the Army, Navy, Air Force, and Industry to provide insight into the tenets of PBL. We found no single definition for PBL. Yet, various PBL definitions revealed several common themes. The three main themes are: 1) integration between acquisition and logistics for total system life-cycle, 2) incentives, and 3) performance goals.

Generally, the contracting agency seeks to improve performance throughout the life of a weapon system in some measurable way without dictating the specific methods of performance. Moreover, the agency is willing to provide incentives to the contractor to meet these performance objectives. PBL integration replaces the practice of attempting to define specific methods of operation by describing desired results and uses incentives to ensure success.

The official definition from the Defense Acquisition Guidebook (2004) is:

> Performance-Based Logistics is the purchase of support as an integrated, affordable, performance package designed to optimize system readiness and meet performance goals for a weapon system through long-term support arrangements with clear lines of authority and responsibility. Application of Performance-Based Logistics may be at the system, subsystem, or major assembly level depending on program unique circumstances and appropriate business case analysis. (p. 5.3)

The Navy provides the inclusive term "provider" which demonstrates that functions can be performed by any entity. A key addition to the Navy definition is the inclusion of the term "empowered," implying that additional power in decision making is granted to the provider. This illustrates the move away from centrally controlled performance to more localized performance. Below is the Department of the Navy (2003) definition.

> A PBL strategy is an agreement, usually long term, in which the provider (organic, commercial, and/or public/private partnership) is incentivized and empowered to meet overarching customer oriented performance requirements (reliability, availability, etc.) in order to improve product support effectiveness while reducing TOC. (p. 1)

The Army elevates PBL to a strategy. While not focused on the customer, per se, the definition does link PBL efforts to the purchase of *readiness*.

> A strategy for weapon system product support that employs the purchase of support as an integrated performance package designed to optimize system readiness. It meets performance goals for a weapon system through a support structure based on performance agreements with clear lines of authority and responsibility. (Hill & Hamerlinck, 2003, p. 7)

The Air Force does not use the term PBL. Instead the Air Force uses Total System Support Responsibility (TSSR), Total System Performance Responsibility (TSPR), Flexible Sustainment, and Total Life-Cycle System Support. While the terms are different, the concepts are the same. Air Force programs focus on systemwide support to provide total system sustainment and system level readiness. The implications of the Air Force definitions are that systems should be acquired and sustained for the long-term. The Air Force concept is similar to definitions used by the Deputy Under Secretary of Defense for Logistics and Materiel Readiness and Naval Air Systems Command (NAVAIR).

Since Industry does not specifically use PBL terminology, no definition of PBL exists. Industry uses the term *Supply Chain Management (SCM)* to describe efforts similar to PBL. In general, the logistics support function involves inclusive contracts with service providers to provide a level of service that is required by the acquiring company. Traditional commercial products seldom require the degree of sophisticated systems as the DoD. However, commercial high technology products do involve high levels of sophistication and exact specifications. In some cases, items that require on-going logistical support and repair are outsourced with a third party managing the entire process.

We developed the following comprehensive definition of PBL to capture the various tenets discussed above.

> An integrated acquisition and sustainment strategy for enhancing weapon system capability and readiness where the contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers, both organic and non-organic to support the end user's (warfighter's) objectives.

DRIVERS OF PBL

In general, DoD focuses on developing programs designed to enhance performance and reduce total system cost over the life of a weapon system. The desire by DoD to change the way they conduct business led to the PBL initiative. Our interviews revealed numerous reasons for the adoption of PBL. We report seven primary drivers for PBL in Table 2.

Inherent in these drivers for PBL is both the perception and the reality that weapon systems are expensive to maintain, difficult to upgrade with new technology, and take a long time to diffuse to the field. Moreover, this is also true for the repair and maintenance of fielded (new and legacy) systems. These PBL drivers focus on changing the current environment by suggesting strategic directions for the future.

TABLE 2. DRIVERS FOR PBL

DRIVERS FOR PERFORMANCE-BASED LOGISTICS
1. Rising cost of maintenance, operations, and support for new and legacy missile systems.
2. Needed tool for Logistics Transformation and other actions required by Congress.
3. Needed reduction of customer wait time in support of the war fighter.
4. Needed modernization of weapon systems to enhance combat capability.
5. Needed solutions to weapon obsolescence problems.
6. Documented savings from commercial logistics support operations.
7. Documented improvements from implementation of performance—based acquisition.

INFRASTRUCTURE CHANGES

A major challenge for conversion to a PBL environment is to adopt business practices more common in commercial organizations. To meet the objectives of PBL, both government and Industry must agree on business practices that provide the greatest value for all parties.

Our research reveals that a move to PBL requires several infrastructure changes. To keep the study at a strategic level, we focused on the need to change the culture of the implementing organization since it was the recurring theme throughout our PBL research. Organizational culture is "a pattern of beliefs and expectations shared by organizational members" (Hellriegel, Slocum, & Woodman, 1986). These shared beliefs and expectations determine the behavior of the members of the organization. Changing organizational culture is complicated by the fact that people tend to surround themselves with others of like opinions and values, thus reinforcing their common beliefs and expectations (Schein, 1981).

For example, an AMC HQ's team identified 21 issues that must be addressed prior to PBL implementation. One-third of these issues reflect a culture or belief that would not be supportive of PBL implementation. Table 3 presents several examples obtained from our interviews of *Old Culture* beliefs that are juxtaposed with PBL examples of *New Culture* or new ways of doing business. Several models for successful change management can be found in the management literature (Camm, Drezner, Lachman, & Resetar, 2001). There are also excellent examples of government success in changing the culture of specific organizations.

To meet the objectives of PBL, both government and Industry must agree on business practices that provide the greatest value for all parties.

For instance, in September 2002, GAO (2002) issued a report that stated, "DLA does not provide a 'single face' to its customers for addressing their issues." Customers are "sometimes confused over whom to call and reported difficulties with getting in touch with the right person to resolve their problems" (p. 21). GAO recommended DLA create a single face to customers to improve customer satisfaction. DLA has since implemented a customer relationship management (CRM) program to learn more about its customers' needs and behaviors. They have also realigned the DLA organization structure. They now have functional field chiefs reporting to directors at headquarters and established a new Customer Operations Directorate.

TABLE 3. CULTURE EXAMPLES

COMPARISON OF CULTURE EXAMPLES

The C-17 aircraft is the focus of a Boeing - Air Force partnership. They do joint off sites and work specifically on their relationship. They have joint weekly, monthly, block, etc., meetings and reviews. Every employee who works on the C-17 wears a plastic card the size of their badge, imprinted with the partnership agreement signed by Boeing and Air Force leaders.	✦ Arms length, adversarial relationship between government and contractor. ✦ All communications in writing to create an audit trail. ✦ Interact as little as possible, conduct bi-annual performance reviews. ✦ Maintain objectivity *don't get too close to the contractor.* ✦ Contractor driven by *profit motive* vs. nation's defense. ✦ Government close holds information.
NAVSEA established an e-marketplace using a one-page flowchart showing what it wanted its electronic services procurement system to look like. The five steps represented the full operating capability (FOC) of the desired system, with the extensions and clouds being areas for future scalability in the eventual system. The Navy simply handed the flowchart to potential vendors and asked them, "How much of this picture can you deliver and at what price?" (IBM - Seaport Study, p. 18)	✦ Lengthy statements of work developed by government requiring office—with an attempt to document every possible situation, process, regulation, milspec, service, and government expectation for the bidders. ✦ Independent government estimates. ✦ Elaborate processing of Statement of Work through technical data, system engineering, legal, etc., all with organization-specific word requirements.
Air Force Joint Surveillance Target Attack Radar System (JSTARS) Total System Support Responsibility (TSSR) partnership has multiple agreements in place supporting the sustainment of JSTARS. In most cases, these agreements stand alone—they are not part of the contract between Northrop Grumman Corporation (NGC) and the Air Force. The Partnering Agreement (PA) between NGC and the Warner Robbins Air Logistics Center (WR-ALC) has been incorporated into the prime TSSR contract as the guiding basis for the Air Force providing the depot-performed workloads to the contractor.	✦ Finger pointing between government and suppliers over delays and cost increases. ✦ Request for Proposal describes services and scope of work in great detail. ✦ Numerous change orders as soon as work starts and RFP omissions are identified. ✦ Government defines service delivery means and process through inclusion of government regulations and directives. ✦ Contract administration role vs. partner role. ✦ Only acceptable relationship is a contractual one.
Sikorsky Aircraft Corporation (SAC) is working side-by-side with Corpus Christi Army Depot (CCAD) to reduce repair/overhaul turnaround time for the H-60. This joint collaboration has improved business processes, depot repair methodology, and more responsive product support, with only four contractor jobs directly attributable to the partnership.	✦ *Expert* role assigned to government employee. ✦ Use of design specifications where the government tells the contractor *how* to provide the service. ✦ Contractors in the government workplace viewed as personal service. ✦ Quality assurance processes defined by government specialists. ✦ Government employee relies on *guidance* from HQ.
The Navy Inventory Control Point (NAVICP) has an F/A-18E/F Integrated Readiness Support Teaming (FIRST) prime contract with Boeing under which Navel Air Depot (NADEP) North Island performs depot repair services to Boeing as a *subcontractor.* Boeing provides funding, repairable units, repair parts, obsolescence management, and shipping. The NADEP North Island provides touch labor, facilities, technical data, equipment, production engineering, and packaging. Fifty-seven government jobs were created or sustained by this partnership.	✦ Contractors are taking jobs away from government workers. ✦ Government is buyer of services, not seller. ✦ All payments to government are deposited in the U.S. Treasury account. ✦ Private sector cannot use government facilities and equipment to perform work.

GUIDELINES FOR IMPLEMENTING PERFORMANCE-BASED LOGISTICS

Based on our research and the incorporation of the findings from RAND and the Aberdeen Group (Camm, Drezner, Lachman, & Resetar, 2001; Leahy, 2003), we propose the following six guidelines to successfully implement PBL:

1. **Assign responsibilities clearly throughout the firm**—Blanket statements about policy changes that imply that *PBL is everyone's responsibility* are typically ineffective. Experience suggests that anything that is everyone's responsibility is no one's responsibility. To varying degrees, the Navy, Air Force, and DLA all address this issue. Each of these organizations requires that responsibility for the success of any PBL program be assigned to a specific unit.

2. **Design metrics to motivate the right behavior**—The cliché *successful firms manage what can be measured* can be overstated. Nevertheless, RAND found that proactive fims *do* rely on metrics as the foundation for managing improvement (Camm, Drezner, Lachman, & Resetar, 2001). Accordingly, metrics designed to motivate the right behavior must be carefully crafted and applicable across the entire organization. Effective metrics must induce the decision maker to pursue [organizational] goals, be compatible with the constraints that the decision maker faces in each setting, be easy to collect and verify, and be mutually understood and accepted by the decision maker and oversight authority (Hellriegel et al., 1986). For instance, Naval Inventory Control Point (NAVICP) is responsible for the Navy PBL program and NAVICP Operations Research (OR) Group is focused on developing appropriate performance metrics for logistical operations.

   Defining the right PBL metrics is difficult for both government and contractors. NAVICP is using its OR group to answer these questions. Initially, it may be easy for contractors to exceed expectations and improve performance. After the initial changes take place, it becomes increasingly difficult to continue to gain higher levels of performance. Contractors and govemment employees predicted future difficulties in this area. For instance, one Navy contractor indicated that he is currently engaged in negotiations for more difficult metrics while his firm's current performance is within acceptable performance expectations. At the same time, NAVICP is attempting to quantify their requirements. For example, NAVICP might purchase a three-day delivery when a ten-day delivery would be acceptable. Finally, metrics and incentives should be designed simultaneously to ensure that performance is measured correctly and rewarded appropriately.

3. **Manage failures to limit disincentives for risk-taking**—Failure is part of the learning process. The term *failing forward,* describes the process of "creating forward momentum with the learning derived from failures" (Leonard-Barton, 1995). While most commercial firms understand failing forward, we found little insight into how to implement the concept in DoD. The PBL requires interdisciplinary organizations and teams, consisting of professionals with advanced interpersonal, analytic, and computer skills, and requires knowledge of contracting, logistics, funds management, metrics,

and organizational effectiveness and efficiency. It also requires building relationships with contractors and operating from a holistic view of the organization.

4. **Develop a supportive organizational context for tools**—These tools include *middleware* to standardize decision making based on legacy system output and tracking systems to document performance improvements and lessons learned across the organization. The Warner Robins-Air Logistics Center(WR-ALC) uses Supply Chain Common Operating Picture (SCCOP) to provide a common operational view of the total supply chain and specific details on all factors that affect weapon system availability. Each data element is obtained from the designated authoritative source for the information. This is accomplished through the retrieval, display, and integration of information captured from multiple legacy data sources.

5. **Manage relationships with stakeholders**—Continuing communication with stakeholders is one way to gain their support. In the case of environmental management, Procter & Gamble invested time to train state regulator personnel on issues relevant to the Industry. The DoD Inspector General (IG) is a similar regulator that may have some difficulty accepting PBL required changes in contract management and administration. The DLA Customer Relationship Management (CRM) Office provides a consolidated approach to developing and delivering information related to DLA business goals to key stakeholders and DLA customers. Using an Integrated Product Team (IPT) network of customer-touch points, strategic level information at headquarters (from public affairs offices and current DLA publications staff) is integrated with field level activities. The CRM office then develops content and tools to provide the needed message to customers.

6. **Benchmark to promote continuous improvement**—In order to find how well initiatives are working, compare results through the benchmarking process. This requires finding the best practices in Industry and government and the identification of those firms and agencies that are the best performer for a specific activity. Utilizing these findings, identify the gaps and develop a plan to close the gaps. In order to be successful in implementing PBL, such benchmarking and improvement processes need to become a habit for an organization rather than ad-hoc actions. Many of the organizations that we interviewed provided insight into how the PBL transition was linked to developing Lean processes. At both the Air Force and Navy, the benchmarks were developed based on the leaner, more efficient organizations and then used to become the basis for continued improvement. The Air Force maintains an on-going contract with RAND to provide benchmarking services

These six guidelines are derived from a variety of lessons learned. We have synthesized our research and the findings of other researchers to provide a starting point for the implementation of PBL. Each organization must create an atmosphere of trust and commitment with both its customers and suppliers. The organization must focus on its core competencies and create relationships or do strategic sourcing with organizations to enhance the value of offerings for customers.

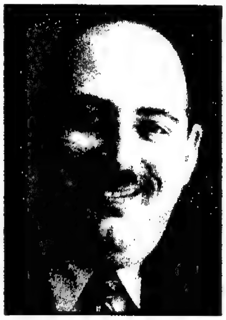
CONCLUSIONS

We have reviewed the best practices and lessons learned in DoD and Industry for managing and sustaining a complex system in a performance-based environment. Specifically, we identified issues and key criteria for developing strategies and policies to define the required relationships, contractual mechanisms, and incentives to achieve the objectives of PBL in government. Our research efforts resulted in the development of a definition of PBL to be used to guide deployment efforts. We also identified the drivers for PBL and the infrastructure changes needed to successfully use PBL in government. Based on our research findings and those of previous related studies in government and Industry, we proposed six guidelines to successfully implement PBL.

...Future research directed toward the development of methodologies and algorithms for creating performance specifications will enhance the implementation and acceptance of PBL approaches in government.

This research also suggests some directions for future efforts needed to successfully implement PBL in government. First, an educational program to clarify the understanding and comprehension of the definition, scope, and purpose of PBL will mitigate some myths and fears about its use. Second, each of the six guidelines requires further research to develop specific policies, procedures, and measures for their use and effectiveness. Third, while the conceptual framework for PBL envisions an organizationwide adoption, in actual practice it is more incremental in nature. Therefore, further research is needed to develop a quantitative method to rank order projects that are candidates for an early adoption of PBL.

Fourth, since the PBL approach emphasizes performance, appropriate performance expectations need to be specified. This requires the development of the performance specifications needed from the customers using the systems being acquired and sustained. Therefore, future research directed toward the development of methodologies and algorithms for creating performance specifications will enhance the implementation and acceptance of PBL approaches in government. Finally, development and implementation of performance-based incentives that include some form of innovation and technology enhancement will be required to realize the full benefits of PBL. While this research has resulted in creating suitable guidelines for implementing PBL, more research is needed to make it a reality.

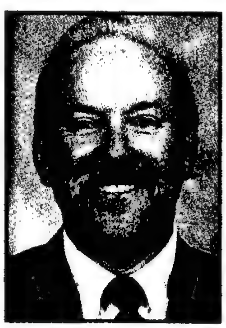


Dr. David Berkowitz is an Associate Professor of Marketing and Director of the Center for the Management of Technology at the University of Alabama in Huntsville, AL. His research has appeared in leading academic journals such as the *Journal of Retailing, Journal of Advertising Research, Journal of Advertising,* and *European Journal of Innovation Management*. At the University of Alabama, Berkowitz teaches Marketing High Technology Products, Managing Technology Development, and Marketing Management.

(E-mail address: berkowd@email.uah.edu)

Dr. Jatinder N. D. Gupta is Eminent Scholar of Management, Professor of Information Systems, Industrial and Systems Engineering and Engineering Management, and Chairperson of the Department of Accounting and Information Systems, University of Alabama in Huntsville, AL. His teaching includes courses in supply chain and logistics management, information technology, and e-business. Recipient of the Outstanding Faculty and Outstanding Researcher awards, he has published numerous books and papers in national and international journals.

(E-mail address: guptaj@email.uah.edu)



Dr. James T. Simpson is the Professor of Marketing and Department Chairman at University of Alabama in Huntsville, AL. His Ph.D. in marketing and applied statistics is from the University of Alabama. Simpson's research has appeared in leading academic journals such as *Journal of Marketing Research, Journal of Business Research, Journal of Systems and Software,* and *European Journal of Innovation Management*. He has lectured in Russia, China, Taiwan, Romania, France, and England.

(E-mail address: simpsonj@email.uah.edu)

Joan McWilliams worked at the U.S. Army Aviation Missile Command (AMCOM) for 20 years. During her last ten years at AMCOM, she served as Chief, Quality Institute where her mission was to improve business processes and develop quality leadership across the organization. She has an masters degree in Industrial Education from the University of Tennessee, Knoxville, TN and an master's degree in Management of Technology from the University of Alabama in Huntsville, AL.

(E-mail address: mcwillj@email.uah.edu)

AUTHOR BIOGRAPHIES

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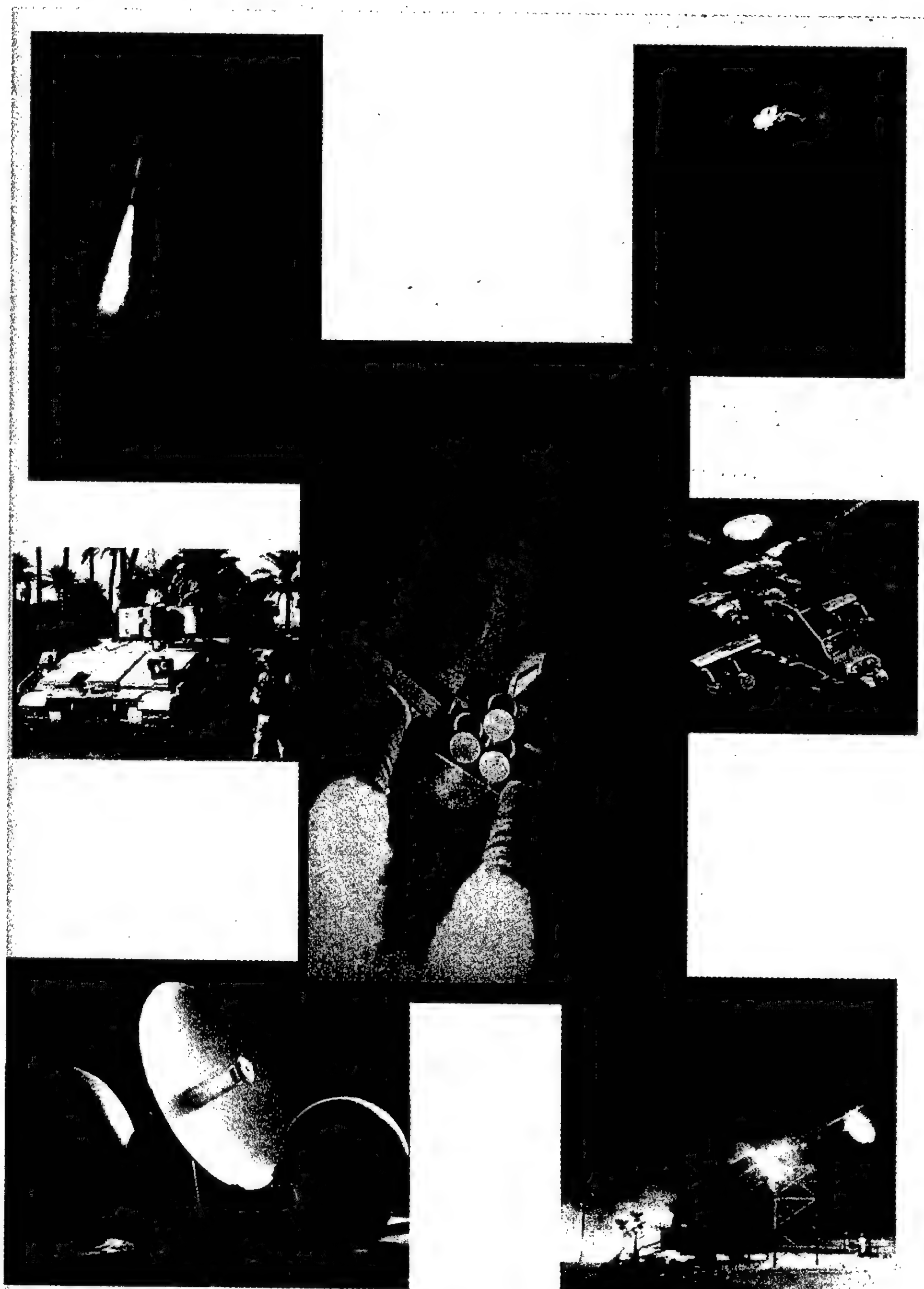

A PERFORMANCE-BASED TECHNOLOGY ASSESSMENT METHODOLOGY TO SUPPORT DOD ACQUISITION

DR. SHERRY MAHAFZA, DR. PAUL COMPONATION, AND DR. DONALD TIPPETT

Many weapon system failures are attributed to premature transfer of technology to operational systems. Insufficient measures of assessing technology readiness are major contributors to such failures. This paper presents a methodology to measure the performance risk of technology in order to determine its transition readiness. This methodology is referred to as Technology Performance Risk Index (TPRI). The TPRI can track technology readiness through a life cycle, or it can be used at a specific time to support a particular system milestone decision. The TPRI is computed using the performance requirements, the Degree of Difficulty (DD), and the unmet performance. These components are combined in a closed-loop feedback manner to analytically calculate the performance risk. TPRI is illustrated by an example using published system requirements data.

Since World War II, the United States Armed Forces have maintained a technological advantage over adversaries. Today, the military is facing continued threats that require an accelerated pace of technology development amid global proliferation of military technologies (Lukens, 2003). The Department of Defense

(DoD) has estimated a need for $50 billion dollars for missile defense research and development over years 2004–2009 (General Accounting Office [GAO], 2003); however, this requirement must be balanced with other funded programs.

The demands to support additional operational tempos, higher maintenance costs for aging weapon systems, and higher system acquisition costs, limit the available funding for new technology development. These increasing demands compete for the same money used for research and development of technology, and often the technology budget is further reduced. Additionally, the impact of company buyouts has reduced the military industrial research base in the United States from 21 companies in 1993 to 5 companies in 2002 (Linster, Slate, & Waller, 2002). Consequently, this has resulted in substantial reduction in Independent Research and Development (IR&D) activities. In today's DoD environment, it is important that investments in technology are successfully transitioned to operational military systems.

Changing to a capability-based acquisition strategy is another indicator of the significance of technology.

Changing to a capability-based acquisition strategy is another indicator of the significance of technology. Mr. Pete Aldridge identified in a memo (Aldridge, 2002) to the Secretary of Defense his intent to accelerate the flow of technology to the warfighter. Later, Mr. Aldridge (2003) announced his goal to initiate high-leverage technologies to create the warfighting capabilities and strategies of the future. Therefore, it is imperative that the technology meets maturity and performance requirements, prior to being transitioned to the acquisition system. Furthermore, a capability-based acquisition strategy will allow acquisition programs to pull advanced technology into systems faster, thus fielding systems with advanced technologies to the warfighter faster. The capability-based acquisition cycle also means that requirements will evolve faster, which mandates close monitoring of systems' requirements and the technologies we use to meet these requirements.

THE PROBLEM

Development of new defense technologies within the DoD is a multi-dimensional problem. First, DoD must resolve issues that result from immature technologies transition. The General Accounting Office (GAO) has stated that immature technology transition is the leading cause of weapon system problems (GAO, 1999). An important factor in the success of a new weapon system is ensuring that technologies are mature

prior to being integrated (GAO, 1999). Second, the creation of parallel paths for the development of technology and the development of an acquisition weapon system has diluted the link between technology and system performance requirements. The technologist has responsibility for managing the development of the technology, while the weapon system acquisitionist has responsibility for the development of the weapon system. Unfortunately, the technologist has different goals, environments, and perspectives than the system acquisitionist (McGrath, 2003). The original reasoning behind this deliberate separation is that it allows the acquisitionist to focus on meeting requirements for the system development, while providing the technologist an environment to explore capabilities of the technology. An unforeseen result of this separation is that two conflicting drives of motivation are generated.

The technologist is motivated to transition technologies into weapon systems. Thus, technologists are optimistic on the maturity assessment of their technology. The acquisitionist is motivated to meet system requirements, and often uses a risk adverse approach for the design process. Consequently, the acquisitionist is more likely to underestimate the maturity of new technologies. This forces the technologist to focus on risk mitigation. These conflicting motivations justify the need for an objective methodology to assess a technologies fit with system performance requirements. As a technology's maturity increases, the criticality for decision support tools to determine transition readiness is also increased. Hence, a common understanding, between the technologist and the acquisitionist, is needed.

PROPOSED METHODOLOGY

One approach to develop a common understanding of technology readiness is to utilize a modified version of Garvey's system performance risk index (Garvey & Cho, 2003). The threshold value of a Technical Performance Measure (TPM) divides performance into acceptable and unacceptable risk regions. In this manner, it is the goal of a system developer to reach the acceptable performance risk region. To get into the acceptable performance risk region, the technology must meet or exceed the identified TPM threshold. Garvey provided guidelines for calculating the achieved performance.

The proposed methodology to assess technology readiness proposed in this paper is referred to as the Technology Performance Risk Index (TPRI). The index is based on the system's performance requirements and the ability of the technology to achieve that performance. The achieved performance is normalized so multiple requirements can be assessed simultaneously. A condensed solution for the two cases of the required performance behaviors is then calculated. In the first case, performance must decrease to meet the established TPM threshold. The achieved performance is computed as the inverse of the percentage of the TPM threshold that the measured performance represents. The achieved performance, A_{ij}, at time i, for TPM j is calculated by:

$$A_{ij} = \min\left\{\frac{threshold}{m_{ij}}, 1\right\} \qquad \text{Equation 1}$$

where m_{ij} is the measured performance. Examples of this type of required performance behavior are weight constraints or mean time to repair TPMs. In the second case, performance must increase to meet the threshold and A_{ij}, at time *i*, for the *jth* TPM is computed using:

$$A_{ij} = \min\left\{\frac{m_{ij}}{threshold}, 1\right\} \qquad \text{Equation 2}$$

Again, m_{ij} is the measured performance. In the increasing performance behavior, the achieved performance is equivalent to the percentage that the measured performance represents of the TPM threshold. Two examples of increase perfomance behavior TPMs would include number of units available or mean-time-between-failures.

Garvey defines the system performance risk index as the amount of the remaining unmet performance relative to meeting a set of identified TPMs. Emphasis is placed on the unmet performance as issues for management to focus and resolve with priorities and allocation of resources. Although Garvey's method provides a quantitative measure of meeting a set of established requirements, it inherently lacks the inclusion of a true risk measure. More specifically, in Garvey's approach, unmet performance does not indicate what it will take to reach the acceptable risk region. It merely provides a measure of progress achieved at a certain time.

Garvey defines the system performance risk index as the amount of the remaining unmet performance relative to meeting a set of identified TPMs.

This article presents a research effort to address the linkage between technologies, system performance requirements and risks in the DoD environment. This methodology is used to measure risk associated with satisfying an identified set of TPMs for a given system. The TPRI provides information regarding performance risk associated with a technology to support the decisions of whether or not a certain technology is ready to be transitioned to an acquisition system. The TPRI offers a measure of the actual performance risk of a technology by providing an assessment of a given technologies ability to achieve performance requirements.

Thus, a common understanding of performance risks between technologist and acquisitionist is accomplished. The impact of the TPRI can be described using the following analogy: a thermostat measures actual outside temperature, yet to a human, the wind chill factor is of more concern. In this same manner, the TPRI is like the wind chill factor, as it affords valuable information that allows insight into the technology that would not be obtained from individual metrics.

Performance-based requirements criteria are typically established by an acquisitionist. Typically, these criteria and the basis for measurement are identified in an agreement with the technologist. This serves as a basis consisting of the individual requirements and associated threshold values against which technologies will be evaluated. This information is utilized to compare against the measured level of performance achieved.

The TPRI extends Garvey's methodology to include a measure of performance risk so that acquisitionists can have access to information that will assist in setting priorities and allocating resources (Garvey & Cho, 2003). For this purpose, the Degree of Difficulty (DD) is the metric utilized by TPRI. The DD metric (Mankins, 1998 & 2002) provides a measure of anticipated risk, ranging from low level risk to high level risk, and can be considered as a probability of failure in regards to the technology achieving the objectives.

In TPRI, the DD metric is modified to assign a numerical value to each of Mankins' defined levels. This provides a quantitative means to combine risks across various requirements. In this context, the DD metric is bounded by zero and one. Table 1 provides a summary of each of the DD levels with anticipated risk, and the numerical value, as well as the theoretical boundary levels. The lower boundary with a DD of zero indicates there is no risk involved in meeting the objectives and is guaranteed success. The DD at level 1 has a very low risk and is assigned a 0.1 value; a DD at level 2 has an anticipated moderate risk and has an assigned value of 0.3, while the DD at level 3 has a high risk, with

TABLE 1. DEGREE OF DIFFICULTY (DD) LEVELS WITH RISKS AND ASSIGNED NUMERICAL VALUES

Degree of Difficulty	Risk Level	DD Value
Level 0 (Theoretical Lower Bound)	No Risk; Guaranteed Success	0.0
Level 1	Very Low Risk	0.1
Level 2	Moderate	0.3
Level 3	High	0.5
Level 4	Very High	0.7
Level 5	Extremely High Risk, Requiring a Fundamental Breakthrough	0.9
Level 6 (Theoretical Upper Bound)	Guaranteed Failure	1.0

a 0.5 value. A technology with very high risk is identified as DD level 4 and has a 0.7 value. In the case that a technology has a high expectation of failure, requiring a fundamental breakthrough, is assigned a DD level 5 with a 0.9 numerical value. In addition, the theoretical upper bound of the DD metric indicates the highest level of risk with no anticipated success (guaranteed failure), and is assigned a value of 1.

A major attribute of TPRI is that it accounts for unmet performance and associated risk to quantify effects upon the achieved performance. Risk is defined as a measure of the probability and the severity of adverse effects (Haimes, 1998). The TPRI is applicable to the technical risk form; referred to as performance risk. The TPMs provide a gauge of technical progress measured against satisfying an identified set of thresholds pertaining to performance requirements. The TPRI correlates the performance risk associated with a technology not meeting the threshold value of a TPM.

TPRI METHODOLOGY

To formulate the TPRI model, the unmet performance and DD are combined to adjust the achieved performance. The TPRI is expressed mathematically as:

$$TPRI = 1 - \frac{A}{1+(1-A)*DD} \qquad \text{Equation 3}$$

The unmet performance, *1–A*, is a measure of the severity component of risk, while DD signifies the probability component of risk. These two components are combined to formulate a measure of performance risk of the unmet performance-based on a closed loop feedback mechanism. This index provides a measure of performance risks to meet the TPM threshold in an effort to reach the acceptable performance risk region goal.

A major attribute of TPRI is that it accounts for unmet performance and associated risk to quantify effects upon the achieved performance.

The behavior of the TRPI model is depicted in Figure 1. The TPRI is plotted versus the performance achieved using DD as a parameter. The TPRI has a value of zero when all the performance measures have been achieved. The DD values that are between the theoretical bounds of zero and one indicate the perceived level of difficulty

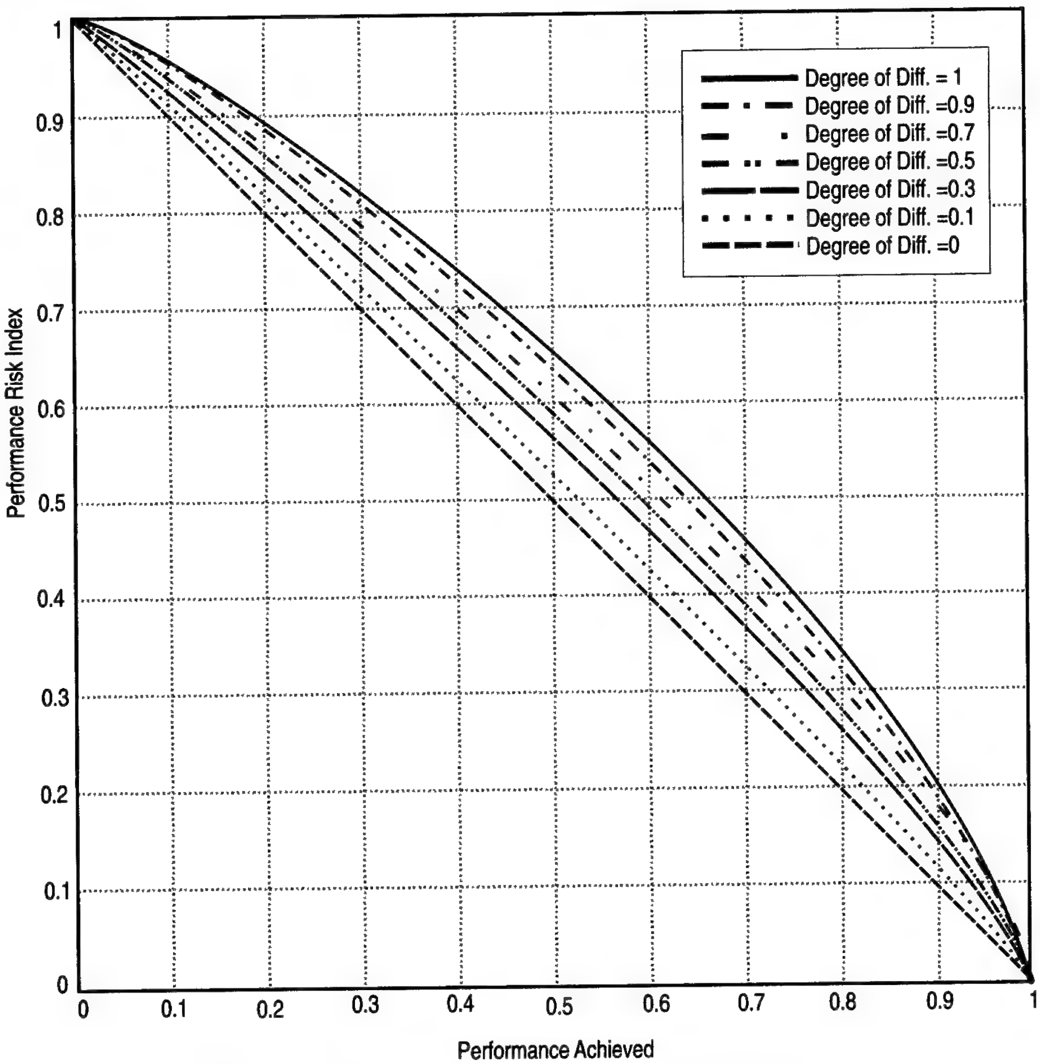

FIGURE 1. TPRI PER ACHIEVED PERFORMANCE WITH DEGREE OF DIFFICULTY AS A PARAMETER

in developing the technology to meet the required system performance requirements.

The theoretical lower boundary of TPRI is identified at DD=0, and corresponds to the line with the lowest TPRI value. This boundary indicates that there is no perceived performance risk with guaranteed success, and it is equivalent to Garvey's approach of unmet performance as the measure of system performance risk. As the DD increases, the TPRI also increases. As expected, non-zero DD yields a non-linear behavior between the achieved performance and the corresponding TPRI value. The DD=1.0 provides the theoretical upper bound, indicating a guaranteed failure. There is a maximum TPRI difference of 0.18 between the two theoretical bounded cases. The TPRI provides a realistic measure

TABLE 2. MEASURED PERFORMANCE OF TPMS PER TIME PERIOD

Technical Performance Measures	Measured Performance, m						
	Threshold	t=1	t=2	t=3	t=4	t=5	t=6
A1 - Average Processing Delay (msec)	1	3	2.86	1.18	1.09	1.03	0.98
A2 - Mean Time to Repair (minutes)	10	50	43	43	27	12	9
A3 - Payload Weight (lbs)	950	2112	1764	1328	1189	1008	948
A4 - Engagement Coordination (sec)	0.01	0.1	0.04	0.032	0.02	0.01	0.01
A5 - Interceptors Available (# of units)	150	67	128	134	139	142	159
A6 - Mean Time Between Failure (hrs)	500	100	189	223	348	379	521
A7 - Single Shot Success Probability (%)	0.95	0.87	0.89	0.91	0.934	0.94	0.99
A8 - Damage Assessment Accuracy (%)	0.995	0.6	0.878	0.94	.0945	0.999	1
A9 - Software Coding (# coded modules)	763	578	643	687	698	723	763

of performance risk associated with the technology to meet, or exceed, the established threshold. Thus, the TPRI yields valuable information to support the acquisitionist and the technologist in making sound decisions regarding the performance risk as a component of the transition readiness of a technology.

ANALYSIS

The TPRI is applied to existing published data (Garvey & Cho, 2003) as shown in Table 2. This data consists of a set of nine TPMs, corresponding threshold values, and the measured performance over the six various points of time. An assessment of the levels of measured performance across each of the TPMs during the time periods is presented. For example, the average processing delay increases in performance by decreasing the average processing delay, measured in milliseconds, from 3 msec at t=1, to 1.03 msec at t=5, to exceeding the TPM threshold (of 1 msec) with a measured performance of 0.98 msec at the sixth time period. The measured performance data contained in Table 2 indicates each of the nine TPM thresholds are either met or exceeded at the sixth time period.

Examples of this decreasing performance behavior would include the following four TPMs: average processing delays, mean time to repair, payload weight, and engagement coordination.

The achieved performances for TPMs with decreasing performance behavior are calculated using Equation 1. Examples of this decreasing performance behavior would

TABLE 3. ACHIEVED PERFORMANCE (PERCENTAGE) OF TPMS PER TIME PERIOD

		Achieved Performance, A					
Technical Performance Measures	Threshold	t=1	t=2	t=3	t=4	t=5	t=6
A1 - Average Processing Delay (msec)	1	0.33	0.35	0.85	0.92	0.97	1
A2 - Mean Time to Repair (minutes)	10	0.20	0.23	0.23	0.37	0.83	1
A3 - Payload Weight (lbs)	950	0.45	0.54	0.72	0.80	0.94	1
A4 - Engagement Coordination (sec)	0.01	0.10	0.25	0.31	0.50	1.00	1
A5 - Interceptors Available (# of units)	150	0.45	0.85	0.89	0.93	0.95	1
A6 - Mean Time Between Failure (hrs)	500	0.20	0.38	0.45	0.70	0.76	1
A7 - Single Shot Success Probability (%)	0.95	0.92	0.94	0.96	0.98	0.99	1
A8 - Damage Assessment Accuracy (%)	0.995	0.60	0.88	0.94	0.95	1.00	1
A9 - Software Coding (# coded modules)	763	0.76	0.84	0.90	0.91	0.95	1

include the following four TPMs: average processing delays, mean time to repair, payload weight, and engagement coordination. In order to meet the TPM threshold, the performance behavior is to be minimized.

In a similar manner, Equation 2 is applied to calculate the achieved performances for TPMs with increasing performance behavior. Examples of this performance behavior would include: number of interceptors available, mean time between failure, single shot success probability, damage assessment accuracy, and number of software modules written. The performance behavior of these TPMs must be maximized to meet or exceed the TPM threshold.

The resulting achieved performance data for each of the nine TPMs and each time measurement are tabulated in Table 3. The achieved performance measure is bounded by 0 and 1. The larger number value of achieved performance indicates that the technology performance is approaching the TPM threshold. An achieved performance of 1 indicates that the technology has either met or exceeded the TPM threshold and has accomplished the goal of entering the acceptable risk region.

Table 4 provides the listing of the nine TPMs and the associated achieved performance. The Degree of Difficulties are arbitrarily selected (for demonstration purposes) for each TPM per each of the six time periods. The TPRI was computed for each individual TPM requirement for each time period. For example, at time period t=1, the average processing delay TPM has a TPRI of 0.75, 0.74 at t=2, 0.19 at t=3, and continues to improve until t=6, when the computed TPRI is zero, indicating that the TPM was met or exceeded.

The total system level TPRI is also calculated for the technology for each of the six time periods. The aggregate TPRI for the technology is computed by averaging the TPRI values of the nine individual TPM requirements, and is identified in Table 4. As the technology advances in improved performance, the TPRI value decreases, indicating lower system performance risks. For example, the aggregate TPRI for the technology is 0.64 for the first time period, 0.49 for the second time period, and continues to improve (decrease) through the sixth time period, when the aggregate TPRI is zero.

Figure 2 depicts the aggregate technology-level TPRI value for each time period. Observation of this figure indicates the areas of significant risk and helps

TABLE 4A. TPMS AND ASSOCIATED ACHIEVED PERFORMANCE

Technical Performance Measures	Achieved Performance t1	Degree of Difficulty	TPRI per Requirement
A1 - Average Processing Delay (msec)	0.33	0.5	0.75
A2 - Mean Time to Repair (minutes)	0.20	0.9	0.88
A3 - Payload Weight (lbs)	0.45	0.5	0.65
A4 - Engagement Coordination (sec)	0.10	0.7	0.94
A5 - Interceptors Available (# of units)	0.45	0.5	0.65
A6 - Mean Time Between Failure (hrs)	0.20	0.9	0.88
A7 - Single Shot Success Probability (%)	0.92	0.3	0.11
A8 - Damage Assessment Accuracy (%)	0.60	0.7	0.53
A9 - Software Coding (# coded modules)	0.76	0.7	0.35
Total TPRI, at t1 = 0.64			

Technical Performance Measures	Achieved Performance t2	Degree of Difficulty	TPRI per Requirement
A1 - Average Processing Delay (msec)	0.35	0.5	0.74
A2 - Mean Time to Repair (minutes)	0.23	0.9	0.86
A3 - Payload Weight (lbs)	0.54	0.5	0.56
A4 - Engagement Coordination (sec)	0.25	0.5	0.82
A5 - Interceptors Available (# of units)	0.85	0.3	0.18
A6 - Mean Time Between Failure (hrs)	0.38	0.9	0.76
A7 - Single Shot Success Probability (%)	0.94	0.3	0.08
A8 - Damage Assessment Accuracy (%)	0.88	0.5	0.17
A9 - Software Coding (# coded modules)	0.84	0.5	0.22
Total TPRI, at t2 = 0.49			

Technical Performance Measures	Achieved Performance t3	Degree of Difficulty	TPRI per Requirement
A1 - Average Processing Delay (msec)	0.85	0.3	0.19
A2 - Mean Time to Repair (minutes)	0.23	0.9	0.86
A3 - Payload Weight (lbs)	0.72	0.3	0.34
A4 - Engagement Coordination (sec)	0.31	0.5	0.77
A5 - Interceptors Available (# of units)	0.89	0.3	0.13
A6 - Mean Time Between Failure (hrs)	0.45	1.9	0.70
A7 - Single Shot Success Probability (%)	0.96	1.3	0.05
A8 - Damage Assessment Accuracy (%)	0.94	0.3	0.07
A9 - Software Coding (# coded modules)	0.90	0.3	0.13
Total TPRI, at t3 = 0.36			

TABLE 4B. TPMS AND ASSOCIATED ACHIEVED PERFORMANCE (cont)

Technical Performance Measures	Achieved Performance	Degree of Difficulty	TPRI per Requirement
	t4		
A1 - Average Processing Delay (msec)	0.92	0.1	0.09
A2 - Mean Time to Repair (minutes)	0.37	0.7	0.74
A3 - Payload Weight (lbs)	0.80	0.3	0.25
A4 - Engagement Coordination (sec)	0.50	0.5	0.60
A5 - Interceptors Available (# of units)	0.93	0.1	0.08
A6 - Mean Time Between Failure (hrs)	0.70	0.9	0.45
A7 - Single Shot Success Probability (%)	0.98	0.3	0.02
A8 - Damage Assessment Accuracy (%)	0.95	0.1	0.05
A9 - Software Coding (# coded modules)	0.91	0.3	0.11
	Total TPRI, at t4 = 0.27		

Technical Performance Measures	Achieved Performance	Degree of Difficulty	TPRI per Requirement
	t5		
A1 - Average Processing Delay (msec)	0.97	0.1	0.03
A2 - Mean Time to Repair (minutes)	0.83	0.7	0.25
A3 - Payload Weight (lbs)	0.94	0.3	0.07
A4 - Engagement Coordination (sec)	1.00	0	0.00
A5 - Interceptors Available (# of units)	0.95	0.1	0.06
A6 - Mean Time Between Failure (hrs)	0.76	0.9	0.38
A7 - Single Shot Success Probability (%)	0.99	0.1	0.01
A8 - Damage Assessment Accuracy (%)	1.00	0	0.00
A9 - Software Coding (# coded modules)	0.95	0.3	0.07
	Total TPRI, at t5 = 0.10		

Technical Performance Measures	Achieved Performance	Degree of Difficulty	TPRI per Requirement
	t6		
A1 - Average Processing Delay (msec)	1	0	0.00
A2 - Mean Time to Repair (minutes)	1	0	0.00
A3 - Payload Weight (lbs)	1	0	0.00
A4 - Engagement Coordination (sec)	1	0	0.00
A5 - Interceptors Available (# of units)	1	0	0.00
A6 - Mean Time Between Failure (hrs)	1	0	0.00
A7 - Single Shot Success Probability (%)	1	0	0.00
A8 - Damage Assessment Accuracy (%)	1	0	0.00
A9 - Software Coding (# coded modules)	1	0	0.00
	Total TPRI, at t6 = 0.0		

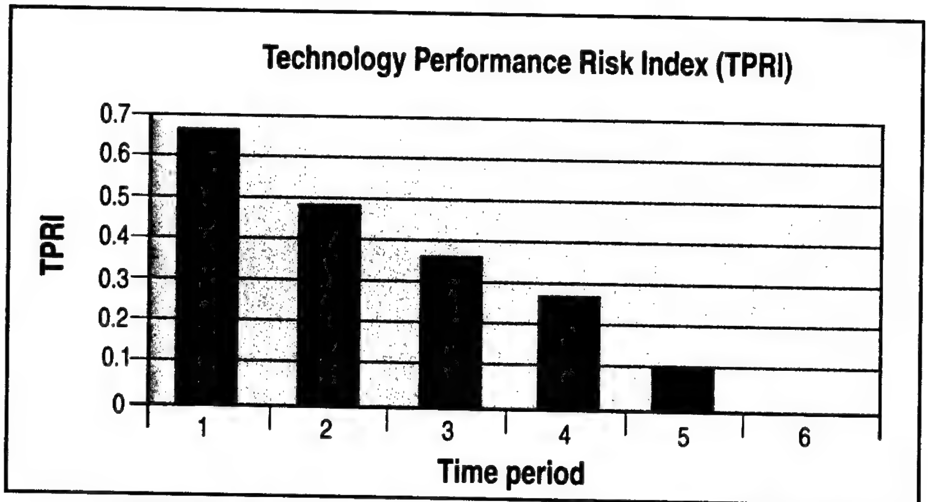

FIGURE 2. SYSTEM-LEVEL TECHNOLOGY PERFORMANCE RISK INDEX PER TIME PERIOD

decision makers with providing additional information pertaining to the performance risk involved with a technology to meet the threshold values associated with TPMs. At the sixth time period, the technology has achieved the acceptable risk region and has a zero-valued TPRI.

TPRI BENEFITS

The TPRI provides a realistic performance risk assessment based on performance requirements, Degree of Difficulty, and unmet performance. These components are combined in a closed-loop feedback manner to calculate the technology performance risk. This decision support tool provides insight to the risk involved in the unmet performance to meet TPM thresholds, and the level of activity required to meet or exceed the threshold. TPRI applies performance risks associated with an unmet requirement as correction/feedback to the achieved performance. Since TPRI is based on meeting TPM thresholds and identifying associated risks with unmet requirement, it provides common ground between technologist and acquisitionist. As a result, an improved understanding of the technology's capabilities to support the acquisition system is gained.

CONCLUSION

This research has focused on the development and demonstration of a quantitative methodology to evaluate and monitor technology to determine transition readiness. The TPRI provides a means to assess potential technologies and assist the decision maker in where to apply resources to address unmet requirements. The TPRI supports monitoring of performance of a technology against threshold limits. It integrates

the technology degree of difficulty along with the system unmet requirements in a closed loop to gain additional information regarding a technology's performance risk over time. Additionally, it reduces the probability associated with immature technology being transitioned to a weapon system prematurely. This approach is anticipated to contribute toward level of success pertaining to the integration of technology into system(s) of the aerospace and defense domains.

NEXT STEPS

Future efforts will include examining methods to combine this quantitative Technology Performance Risk Index (TPRI) with a technology maturity metric, such as the widely utilized Technology Readiness Level (TRL). Various ranking and weighting schemes are planned to be examined for potential applicability in the TPRI calculation. There are plans to apply the TPRI as a decision support tool to assist a decision maker with evaluating and selecting the best of identified multiple technologies across same set of TPMs.

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Dr. Sherry Mahafza is a systems engineer at the U.S. Army Space and Missile Defense Command. She holds three Defense Acquisition Workforce Improvement Act (DAWIA) level III certifications in program management and in Systems Planning, Research, Development and Engineering for Systems Engineering as well as Science and Technology Manager career fields. She also holds a bachelor's and master's degrees in electrical and computer engineering, and is currently pursuing a Ph.D. in systems engineering from the University of Alabama in Huntsville. The current article is based on her dissertation research and is supported by the U.S. Army Space and Missile Defense Command.

(E-mail address: sherry.mahafza@us.army.mil)

Dr. Paul J. Componation is an associate professor of Industrial and Management Systems Engineering with The University of Alabama in Huntsville (UAH) and the Systems Engineering Resident Research at the Marshall Space Flight Center in Huntsville. His primary research interests are in technology and system development. His professional affiliations include the Institute of Industrial Engineers (IIE), the International Council on Systems Engineering (INCOSE) and the American Society of Engineering Management (ASEM).

(Email address: pjc@ise.uah.edu)

Dr. Donald D. Tippett holds masters and doctoral degrees in industrial engineering from Texas A&M University, and a bachelor's degree in mechanical engineering from the U. S. Naval Academy. He is a member of the engineering management faculty at the University of Alabama in Huntsville. His previous experience includes 10 years active duty as a carrier-based naval aviator with the U. S. Navy. He held a project management position in materials management systems with Union Carbide Corporation and served as program manager, advanced technology with Newport News Shipbuilding.

(Email address: tippett@ise.uah.edu)

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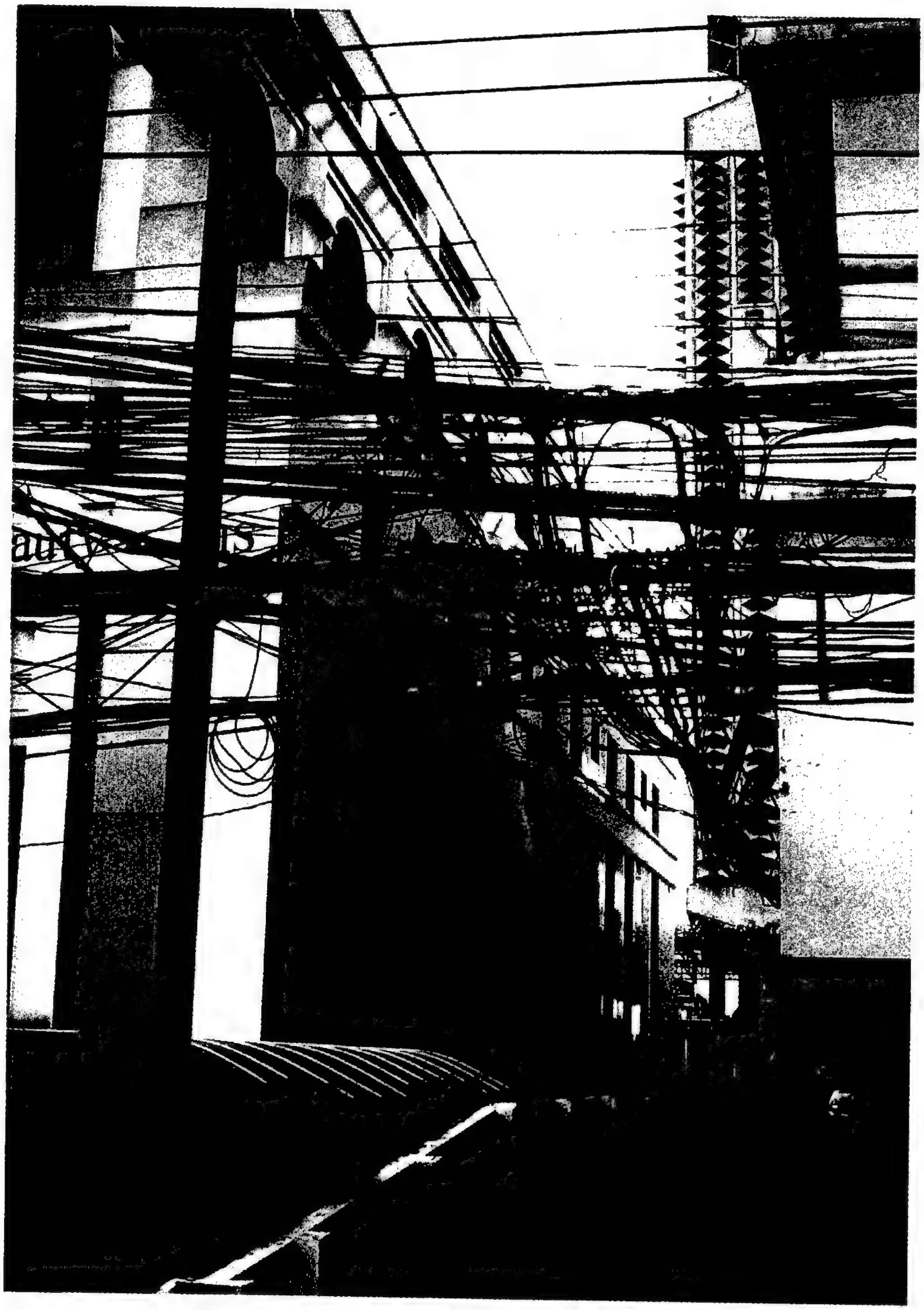


SERVICE LEVEL AGREEMENTS AS VEHICLES FOR MANAGING ACQUISITION OF SOFTWARE-INTENSIVE SYSTEMS

CDR LEONARD T. GAINES, USN AND
DR. JAMES BRET MICHAEL

Service level agreements (SLAs) can be used as a means to manage the acquisition of software-intensive systems. The SLAs support performance-based acquisition by stating in measurable terms the service to be performed, the level of service that is acceptable, the way in which the service level is to be measured, and the incentives for the provider of information technology products and services to meet the agreed-to target levels of quality. The SLAs are traditionally used in outsourcing contracts for post-production support. This article proposes a new approach by using SLAs in software acquisition to support quality and process control throughout the entire lifecycle of a software-intensive system. This article defines SLAs, discusses software quality, and describes how SLAs can be utilized to incorporate requirements pertaining to product, process, project, and deployment quality throughout the software lifecycle.

As advances in information technology (IT) increase worker productivity and encourage the adoption of new ways of conducting business, organizations and end users become ever increasingly dependent upon that technology. Consequently, the strategic and tactical advantages that IT affords an organization places pressure on the organization's IT department to provide quality services and products. Interruptions to software-intensive systems are having a far greater impact than before in terms of opportunity loss, revenue loss, customer dissatisfaction,

and inefficiency. As managers realize that their mission-critical processes are tied to IT services and products, they are demanding correspondingly greater levels of both performance and quality in these services and products, despite the fact that acquiring and maintaining software-intensive systems is increasingly challenging from both a managerial and technical perspective.

In addition, an organization may not have enough personnel with the right mix of IT skills, knowledge, and experience within their organization to provide high-enough quality IT products and services for the organization's employees and business partners. Rather than hire IT specialists or invest in training for its internal staff, the organization may have the option to outsource to external service providers (ESPs) their IT services and products. This strategy has been followed by the U.S. Department of Defense (DoD) in procuring large software-intensive systems such as the well-known Navy/Marine Corps Intranet (NMCI) and Ballistic Missile Defense System (BMDS). The hope is that ESPs can readily supply different mixes of IT specialists to meet the ever-changing requirements an organization has for IT products and services, at a lower cost than enlarging, shrinking, or retraining its internal IT staff. In addition to providing access to cutting-edge technology and skilled staff, ESPs share the project risk and make it possible for organizations to concentrate on core competencies (King, 2001).

Reliance on outsourcing adds another layer of complexity onto the management of information systems.

Reliance on outsourcing adds another layer of complexity onto the management of information systems. Outsourcing efforts require additional discipline and management oversight that may not be necessary with in-house development or maintenance of information systems. Outsourcing requires skill in software acquisition as well as project management. Program managers need to be accomplished in software-requirements engineering, software development, the contracting process, requirement-change management, contract management and oversight, and contractor-relationship management.

When outsourcing software-intensive programs, the program manager must be explicit in stating the services to be performed, in addition to identifying the metrics and means to determine whether the contractor has satisfied those requirements. However, it is challenging to develop, manage, and enforce a contract for software services that will ensure that the contractor delivers the specified services or end product within prescribed levels of performance and quality.

Managing software-intensive information systems can also be challenging. Utilizing the latest technology to exploit information requires highly developed intellectual and managerial skills. The difficulty in managing these systems has been demonstrated by the numerous system development and maintenance projects within the U.S. Department of Defense. Many of these projects lacked sound planning, had inadequate controls, were without effective measurements for success, and failed to meet user expectations (U.S. General Accounting Office [GAO], 2001; Department of Defense, Office of the Inspector General [DoD OIG], 2000). However, the private sector also has problems managing IT projects. The 2003 Standish Group's CHAOS research report indicates that of the 13,522 IT projects studied; only 34 percent of projects were considered a success, and only 52 percent of required features were incorporated into the released product (Standish Group, 2003).

Despite software's increased importance to organizations, the quality of software is often lacking.

Despite software's increased importance to organizations, the quality of software is often lacking. Some would argue, such as Mann (2002), that despite the advances in software engineering theory, processes, methodology, and tools, software quality is actually getting worse. Mann's reasons center around four main points: 1) developers are rushing software to market, 2) software is poorly designed, 3) developers and testers lack the requisite skills, and 4) programs are not managed well. Given the difficulties in developing software-intensive systems, performance and quality requirements should be well defined and monitored throughout the software's lifecycle. In this paper we explain how service level agreements (SLAs) can be utilized in software acquisition to improve the quality and management of software throughout its lifecycle.

SLAs are a means of incorporating Performance-based Service Contracting (PBSC) into software acquisition. SLAs are similar to a Quality Assurance Plan (QAP) in that they define quality and performance requirements, they contain penalties for non-performance, and they establish quality control methods to ensure compliance.

METHODS

In this article we identify areas throughout the lifecycle (requirements generation through post-production support) of software-intensive systems in which SLAs can be used to manage the contractual provisions of insourced or outsourced

IT services and products. In this section we define terms associated with SLAs and quality, in addition to describing how SLAs can be utilized in requirements engineering, design, post-production support, and program management to achieve target levels of performance and quality for IT services and products.

An SLA is a contractual mechanism between a provider of services and a customer that defines a level of performance (Sturm, Morris, & Jander, 2000). This agreement defines in measurable terms the service to be performed, the level of service that is acceptable, the means to determine if the service is being provided at the agreed upon levels, and incentives for meeting agreed upon service levels. SLAs contain quality-of-service (QoS) requirements, including how QoS is to be measured. SLAs also set forth the roles and responsibilities—in contractual form—of both the organization and the provider of the services and products.

...Ever-growing reliance on software-intensive systems for conducting business and recent advances in both techniques and tools for specifying SLAs and monitoring compliance to SLAs have all contributed to the rise in the acceptance of SLAs within the public and private sectors.

SLAs are not a new concept: they have been around since the 1960s. However, ever-growing reliance on software-intensive systems for conducting business and recent advances in both techniques and tools for specifying SLAs and monitoring compliance to SLAs have all contributed to the rise in the acceptance of SLAs within the public and private sectors. If SLAs are not included in a system-acquisition contract, the acquiring organization has little leverage over the provider of the IT services or products to ensure that the organization's performance and QoS requirements are met.

There is a subtle distinction between an SLA and a traditional contract requirement. SLAs are also requirements, but they are different contractually: SLAs contain more detail, describe incentives for meeting thresholds, and specify incentives for meeting performance and QoS requirements. When SLAs are used, the contracting officer can withhold incentive payments or levy penalties if quality levels are not met during the time period stated in the SLA (usually a month or a quarter). Requirements are generally only measured at the end of a milestone decision. In most contracts, the only recourse if a requirement is not met is to cancel the contract, terminate any ongoing contractor support, or give the contractor a poor performance rating. Terminating a project can be difficult, especially if the software-intensive system to be acquired is mission-critical. SLAs specify the degree of recourse if a requirement is not met.

One of the ways that SLAs can help improve software quality is that they focus the attention of the acquisition professional on the nonfunctional requirements (e.g., reliability, security, testability) that otherwise might be ignored until the test phase in the absence of SLAs (Bass, Clements, & Kazman, 1998). SLAs contractually mandate the performance and quality attributes that users, program managers, and software engineers consider essential for a system to support the underlying business process. They help make explicit many of the quality factors that users may implicitly assume. SLAs also specify the quality metrics by which the software quality requirements are measured. Measuring and monitoring performance and quality of services and products makes it possible for an organization to judge whether performance and quality requirements have been met. Measurements also support early detection and resolution of problems with quality.

Quality can be viewed from numerous perspectives, and certain attributes are more preferable to others depending on the mission the software-intensive system is supposed to support.

Before discussing SLAs and how they can improve the performance and quality in the various phases of a software-intensive system's lifecycle, we first define the term *software quality*. There are numerous definitions of quality. The International Standards Organization (ISO) standard 9126 defines software quality as the totality of features and characteristics of a software product that bear on its ability to satisfy stated or implied needs. Another definition is that software quality is conformance to explicitly stated functional and performance requirements, explicitly documented development standards, and implicit characteristics that are expected of all professionally developed software (Pressman, 2001). Others believe that an IT system will not be perceived as a quality product if the product does not perform according to the end-user's perspective (Wiegers, 2002). The Institute of Electrical and Electronics Engineers (IEEE) standard 610-1990 does incorporate user needs: it defines software quality as the degree to which a system, component, or process meets specified requirements and meets customer or user needs and expectations (Schmidt, 2000).

In this article we adopt the IEEE definition and specialize it to encompass four specific areas of focus: 1) product quality, 2) project quality, 3) process quality, and 4) post-production quality. Each of the areas has quality attributes associated with it that describe the degree to which the software possesses certain characteristics. SLAs utilize quality metrics and threshold levels to assign quantitative measurements to the quality attributes. The quality metrics are then monitored to ensure compliance.

Quality can be viewed from numerous perspectives, and certain attributes are more preferable to others depending on the mission the software-intensive system is supposed to support. Numerous quality attributes and quality models have been developed to measure or predict software quality. Selecting the appropriate quality attributes for the project is the responsibility of the SLA development team, the program manager, and stakeholders.

PRODUCT QUALITY

Product quality is concerned with the relationships between the characteristics and attributes of a product and its ability to satisfy stated requirements and implicit needs; this area can also be referred to as end-product quality. In addition to the functional aspects of a system, the end users want the product to exhibit certain quality characteristics that will assist them in performing their task. From a user's perspective, some of the common quality attributes include availability, usability, integrity, interoperability, and reliability. Personnel involved in the development of software or its maintenance may be more concerned with the software attributes such as portability, testability, maintainability, and reusability (Wiegers, 2002).

The ISO standard 9126-1 quality model incorporates the following quality factors: functionality, reliability, usability, efficiency, maintainability, and portability.

There are numerous quality models that can be incorporated into SLAs that assign quantitative measurements to various product quality attributes. Some of the better-known quality models include those proposed by McCabe in which software complexity is a function of the number of conditional statements in the code, and those of Halstead in which software complexity is a function of the number of operators and operands (Ogasawara, Yamada, & Kojo, 1996). The ISO standard 9126-1 quality model incorporates the following quality factors: functionality, reliability, usability, efficiency, maintainability, and portability (Cross, 2002). There are also numerous software quality models that concentrate on specific quality factors such as complexity. Zuse (1991) identifies over 90 models for describing software complexity. Other quality models are specific to object-oriented systems (Coppick & Cheatham, 1992), specific languages (Pritchett, 2001), commercial off-the-shelf (COTS) components (Bertoa & Vallecillo, 2002), and others, are only applicable at run-time (Bass et al., 1998).

PROJECT QUALITY

Project quality is concerned with metrics that allow an organization to manage, track, and improve the quality of the software development effort; this area could be viewed as in-process quality management (Hilburn & Townhidnejad, 2000).

Some of the common project quality metrics that Motorola used to measure its software development projects included software defect density, adherence to schedule, estimation accuracy, reliability, requirements tracking, and fault-type tracking (Daskalantonakis, 1992). Another metric used in assessing project quality is risk, which can be defined as any variable within a project that results in project failure. General risk areas are schedule risk, requirements risk, budget risk, and personnel risk (Padayachee, 2002). There are a number of risk-assessment models including Gilb's (1993) risk heuristics, Boehm's (1991) classification of risk, Noguiera de Leon's (2000) risk assessment model, Keil's identification of risk factors (Keil, Cule, Lyytinen, & Schmidt, 1998), and risk models associated with enterprise software projects (Sumner, 2000).

PROCESS QUALITY

Process quality is concerned with the processes, planning, and controls used to develop and manage the software product. It could be argued that the quality of the development process is the best predictor of software product quality (Fenton, Krause, & Neil, 2002). Repeatable software processes such as the Software Engineering Institute's Capability Maturity Model for software (SW-CMM also known as CMM), which lists five levels of organizational maturity, and the ISO 9001, are designed to improve software quality, productivity, predictability, and time to market (McGuire, 1996). There is empirical evidence that supports the relationship between process maturity and software quality (Harter & Slaughter, 2000).

Process quality is concerned with the processes, planning, and controls used to develop and manage the software product.

Other models of process quality include the Software Engineering Institute's new Capability Maturity Model Integration (CMMI). CMMI integrates three CMM models into one to eliminate problems with different architecture, semantics, and approaches. Humphery (1996) also developed a process model called the Personal Software Process (PSP) to assist software engineers in producing quality software. Other process models include cleanroom engineering that has shown reduced errors per KLOC for small projects (Fenton & Neil, 1999), and the quality management metric (QMM) (Osmundson, Michael, Machniak, & Grossman, 2003). There are also numerous IEEE and ISO standards that provide processes on everything from software engineering product evaluation (e.g., ISO/IEC 14598) to selecting appropriate quality metrics (e.g., IEEE Std. 1061-1998).

POST-PRODUCTION QUALITY

The last area of focus is on post-production quality or deployed-application management. Many of the quality models involving deployed applications are concerned with software maintenance and the quality factors that make maintenance cost-effective. Some of the maintenance quality factors deal with ease of change (Royce, 1990), architectural design to promote maintenance (Garlan, 2000), defect management (Kajko-Mattsson, 1998), organizational structure (Briand, Melo, Seaman, & Basili, 1995), and change management (Bennett & Rajlich, 2000).

Quality does not only apply to the application itself, it is also concerned with the IT system as a whole, across distributed components. Part of that distributed system is the network. There are numerous quality metrics that can be applied to network QoS (Moeller et al., 2000). Quality metrics are also applied to the host server. Quality metrics such as application resource utilization (Aries, Banerjee, Brittan, Dillon, Kowalik, & Lixvar, 2002), bandwidth utilization (Eager, Vernon, & Zahorjan, 2001), concurrent user management (Aweya, Ouellette, Montuno, Doray, & Felske, 2002), and server performance (Gama, Meira, Carvalho, Guedes, & Almeida, 2001) are also utilized to address system-level quality. Other areas where quality metrics are applied include total cost of operation (TCO), help desk support metrics, backups, storage, configuration management, and security.

When developing the SLAs, it is essential that all stakeholders be represented in this effort, as the system requirements need to represent all of their needs for quality.

There are numerous software quality models and metrics that can be incorporated into SLAs. The models or quality factors chosen will depend upon those quality attributes that best support the underlying business processes of the organization acquiring the software-intensive system. SLAs should only incorporate software metrics that are meaningful, quantitative, and measurable.

When developing the SLAs, it is essential that all stakeholders be represented in this effort, as the system requirements need to represent all of their needs for quality. The development team, consisting of representation for all stakeholders, must resolve a number of issues. These include, for instance, identifying quality requirements, determining the various levels of service that are needed, detailing quality metrics that are meaningful and measurable, assessing risk, resolving conflicting quality requirements, and prioritizing the quality requirements. When quotations are received from vendors (i.e., the providers of IT services and products),

the group also needs to perform a cost-benefit analysis based on the levels of quality thresholds desired and the budget allotted for the acquisition. The group development of SLAs helps the various stakeholders understand each others' biases, viewpoints, concerns, terminology, and perceptions—that understanding is essential in requirements engineering.

REQUIREMENTS ENGINEERING

Requirements engineering provides the building blocks for all other efforts in the software-engineering process, so if quality is not addressed in the initial requirements analysis, it is usually addressed at the end of the project in the form of testing. If quality requirements are implemented too late, the architecture that was already developed will dictate the solution space for addressing quality problems that are discovered, or the acquisition authority will need to approve major contract modifications to permit changes to the requirements, architecture, and other high-level system artifacts.

Requirements engineering provides the building blocks for all other efforts in the software-engineering process, so if quality is not addressed in the initial requirements analysis, it is usually addressed at the end of the project in the form of testing.

The process of developing the SLAs is part of the larger requirement-engineering process and fosters discussion of the following: the goals of the system that must be met, the processes and tasks that the system must perform to meet those goals, and any operational and organizational needs, policies, standards, and constraints. Discussions necessary to develop the SLAs will generate information about the application domain, business and organization processes/culture, and the intended operating environment that the system will be placed in. The discussions will help the requirements engineer capture tacit knowledge, identify constraints, prioritize requirements, and justify how quality factors support business needs. Additionally, SLAs require quantifiable quality metrics, so those quality requirements that cannot be measured, do not provide value, or are not realistic should not be accepted by the SLA development team or the requirements engineer.

In many organizations, senior management's involvement in requirements engineering can be low (Bubenko, 1995), resulting in requirements that may not be related to business visions and objectives. SLAs help mitigate this problem because they define specific performance parameters that are tied to business processes. As such, every SLA performance requirement must be analyzed, and validated to ensure that it is meaningful, cost-effective, and that they add to improving overall performance. Senior management may also take more notice when there are contractual repercussions (i.e., penalties or rewards) associated with the requirements.

Incorporating standards in SLAs provides a common methodology that makes management easier for program managers and contracting officers as they provide the basis against which activities can be measured and evaluated (Horch, 1996).

By defining meaningful and measurable metrics in the SLAs, the end-users, business managers and software engineers have realistic quantifiable requirements that can be used to develop architectures, designs, and other software artifacts.

DEVELOPMENT

The real contribution of SLAs in obtaining quality software is that the quality factors addressed in the SLAs drive significant architectural and design decisions. If developers know which of the characteristics are most critical to project success, they can select the architecture, design, programming, and verification and validation approaches that best achieve the specified quality goals. When customer requirements have been collected and specified, architecting and designing translates the requirements into a blueprint that programmers can use to build the product. That design can be evaluated and monitored to ensure quality factors are adequately addressed. In this way, quality is designed in the beginning phases of the lifecycle where it is most cost-effective to do so.

The architecture of a software system models its structure and behavior (Shaw & Garlan, 1996). Architecture also shows the correspondence between the system requirements and the elements of the constructed system; so by analyzing the architecture it is possible to predict the quality of a product before it has been built. There are a number of methods to analyze architectures (Bass et al., 1998). However, these methods do not produce quantifiable quality measurements (Dobrica &

Niemela, 2002), although they can provide an estimate of how well the design will satisfy a particular quality factor.

SLAs also improve software quality in the development phase by contractually mandating that certain quality-control measures (e.g., adhering to specified standards and processes) be performed. There are numerous industry-approved standards that can be incorporated into SLAs. Incorporating standards in SLAs provides a common methodology that makes management easier for program managers and contracting officers as they provide the basis against which activities can be measured and evaluated (Horch, 1996). Standards can be applied to all aspects of development, maintenance, and operation of an information system.

Development processes can be specified in an SLA. Specifying specific processes has many of the same advantages of specifying compliance to standards. Applying well defined, standardized software-development processes can increase software quality and make the development effort more cost effective and predictable (Gnatz, Marschall, Popp, Rausch, & Schwerin, 2003). Specifying the processes in the SLA helps to ensure that they are recognized and adhered to.

Applying well defined, standardized software-development processes can increase software quality and make the development effort more cost effective and predictable (Gnatz, Marscahll, Popp, Rausch, & Schwerin, 2003).

SLAs also assist the testing effort by identifying business-critical processes, defining quantitative metrics to measure quality factors, identifying testing procedures, and ensuring testing is conducted throughout the system's lifecycle. SLAs can ensure that other audits such as documentation reviews, requirements reviews, design reviews, test plan reviews, user documentation reviews, and implementation reviews are conducted (Horch, 1996).

PROGRAM MANAGEMENT

Program managers have to ensure that quality considerations are addressed early in the lifecycle and they must provide the proper amount of oversight to ensure those quality factors are incorporated into the final product. SLAs can assist program managers in many of the tasks necessary to ensure quality is delivered in the final and future versions of a product.

In order to reduce and manage risk, program managers need to measure or monitor contractor, project, and system performance throughout the project's lifecycle. This will help ensure that standards, processes, and quality requirements are being met. SLAs mandate monitoring of the quality requirements associated with product, process, project, and post-production quality. If quality levels are not met, program managers and the contractor are informed of the violation and potential risks; that knowledge may lead to closer monitoring or corrective action to reduce risk and improve quality.

The development of SLAs provides information that will assist the program manager in managing the project's finances. SLAs help financial management in determining the scope of the project (e.g., determining areas of responsibilities in an end-to-end performance SLA), identifying business-critical processes and functions, they help to allocate costs among business units, they provide justification for service-related expenditures, and they help coordinate the IT strategy with business strategies (e.g., applying funds toward services to support critical processes).

Contract oversight is easier when SLAs are established because they can be used to define the levels of service expected, explain how the measurement will be conducted, identify responsibilities, and set forth escalation procedures.

Quality control consists of the actions necessary to certify that desired standards, processes, and quality requirements are adhered to during design, implementation, and production (Tricker & Sherring-Lucas, 2001). SLAs are a quality-control mechanism. SLAs help the program manager by contractually mandating that certain quality-control methods be implemented.

Contract oversight is easier when SLAs are established because they can be used to define the levels of service expected, explain how the measurement will be conducted, identify responsibilities, and set forth escalation procedures. The monitoring mandated by SLAs helps the program manager determine whether the contractor is meeting the quality requirements. When determining what quality metrics are included in the SLAs, it is helpful to determine the behavior you want from the contractor, and determine what measurements will most likely encourage that behavior (Kendrick, 2003).

SLAs help institutionalize a change review board to continually review the SLAs, evaluate new requirements, and ensure maintenance actions do not affect the SLAs.

The change review board ensures that only authorized changes are enacted, that changes are tested against quality levels, that changes conform to architectural constraints, and those changes are properly documented. SLAs can also be written to specify quality requirements that deal specifically with the accuracy or effectiveness of configuration identification, configuration control, configuration accounting, and configuration audits.

In addition, SLAs provide a basis for common understanding of the services that will be performed, the levels of service to be expected, how they will be measured, as well as define the responsibilities of both parties to an SLA. Both parties must mutually agree upon contractual SLAs, or there will never be a contract. It is commonplace to negotiate on the services and the performance levels that are requested and ultimately agreed upon. An SLA should contain a definition of service requirement that is both achievable by the provider and affordable by the customer. The customer and the ESP must also define a mutually acceptable set of indicators of the quality of service (Sturm et al., 2000). Note that SLAs can and should be modified throughout the lifecycle of a system as requirements change, technology improves, and efficiencies are gained.

The use of SLAs helps to ensure that customer expectations are being met by establishing performance and quality objectives, and providing the metrics and a measurement methodology to ensure that those requirements are being met.

The use of SLAs helps to ensure that customer expectations are being met by establishing performance and quality objectives, and providing the metrics and a measurement methodology to ensure that those requirements are being met. An important part of customer service is monitoring the performance of the system to ensure that it is supporting the critical business processes in a manner acceptable to the customer. The fact that SLAs specify what is acceptable makes it easier for program managers to manage expectations.

SLAs can be valuable to organizations that lack the proper IT skills to contract with ESPs. Template SLAs, or pre-existing SLAs, which represent best business practices, can be used as a starting point in formulating SLAs that are unique to specific applications. SLA templates are a starting point for program managers to develop their own SLAs. The templates are helpful in generating questions regarding services and service levels that should be provided to support or develop applications. The program managers only have to modify the existing SLAs to best support their application.

DEPLOYMENT SUPPORT

Quality control does not stop once a software product has been deployed. Quality requirements still need to be applied to the application performance, maintenance efforts, and hosting services throughout its lifecycle. Monitoring the performance of the application once it is deployed is essential in quality control and maintaining customer satisfaction. Much of the application performance monitoring in the initial phases of deployment is to validate product-quality requirements identified in the initial requirements. However, in the deployment environment there is also an emphasis on monitoring system performance in terms of resource utilization, application security, application reliability, application maintainability, database performance, and server performance.

Quality requirements associated with deployed software take a holistic view of the entire system, including distributed components. Quality requirements should be applied to network performance, host environment security, disaster recovery, storage solutions, problem management, concurrent user management, as well as end-to-end performance. Monitoring of the network, hardware, operating system, and the application not only assists in problem resolution, but trend analysis can indicate potential problems before they become unwieldy.

SLAs can be utilized for maintenance actions when patches or new versions need to be developed and deployed. SLAs utilized in the development phase may be used in some circumstances with maintenance actions.

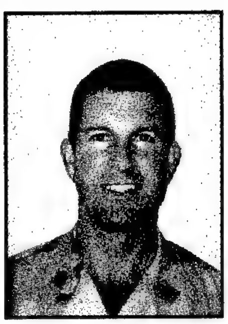
CONCLUSION

SLAs are performance-based instruments for acquiring software. SLAs can be used to specify software quality, but they are also useful for specifying performance requirements. We have described how SLAs can drive product, process, project, and deployment quality solutions. SLAs can help ensure that quality requirements are identified and established early in the development cycle in order to be incorporated into preliminary designs. SLAs can help program managers establish quality controls to monitor and manage the various aspects of the projects. SLAs also carry sufficient weight through incentives to focus management and contractor attention on the quality issues for a software-intensive system that affect the ability of the acquiring organization to perform its mission.

Future research that can build upon the foundations set forth in this paper include evaluating SLAs in actual contracting to analyze quality improvements, determining which quality models and quality attributes are best suited for different types of IT systems, and evaluating or generating tools necessary for measuring end-to-end SLA measurements, such as response time and availability.

All organizations want world-class quality levels, but achieving those quality levels requires a holistic view of quality that incorporates leadership support, repeatable and measurable quality processes and controls, resource planning, vision, customer support, and service-level management. Organizations must do more than identify and incorporate quality attributes in their requirements: they must

also monitor quality metrics to ensure those quality requirements are being met. SLAs are instruments that can be used to establish quality controls. Quality is not something that is inherent in the development process; it must be planned, monitored and incorporated as part of standard business practices.



CDR Leonard T. Gaines, USN is a Supply Corps Officer currently assigned to the Joint Logistics Operation Center at the Defense Logistics Agency. He has a master's degrees from the Naval Postgraduate School and the Industrial College of the Armed Forces. He has served on three ships and has had shore assignments in logistics, acquisition, and information technology. He is a member of the Acquisition Professional Community.

(E-mail address: gaines@dla.mil)

Dr. James Bret Michael is an Associate Professor of Computer Science and Electrical & Computer Engineering at the Naval Postgraduate School. His research and teaching interests center on distributed computing and software engineering as they apply to ballistic missile defense and information warfare. He serves on several government, editorial, and industry advisory boards. Michael has a doctorate degree from George Mason University and is a senior member of the Institute of Electical and Electronic Engineers (IEEE).

(E-mail address: bmichael@nps.edu)

AUTHOR **BIOGRAPHIES**

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PUBLIC AND PRIVATE PARTNERSHIPS IN SUPPORT OF PERFORMANCE-BASED LOGISTICS INITIATIVES—LESSONS LEARNED FROM DEFENSE LOGISTIC AGENCY PARTNERSHIPS

DR. GLENN L. STARKS

Per *Product Support for the 21st Century: A Program Manager's Guide to Buying Performance, November, 2001* published by the Defense Acquisition University, Performance-Based Logistics (PBL) is the preferred approach for implementing weapon system support. While PBL initiatives enhance weapon system support by employing best commercial practices in providing an integrated and performance-based supply chain, they often do not combine the best of government support with commercial support. This results in dual infrastructures, increased costs, and other disadvantages. This article addresses the advantages of combining public and private support by discussing lessons learned from two PBLs where the Defense Logistics Agency has become the source of supply to commercial vendors awarded PBL contracts by the Military Services.

Performance-Based Logistics (PBL) contracts enhance the support of Military Service weapon systems by employing the purchase of total or partial system support as an integrated performance package from a single source. Per the publication *Product Support for the 21st Century: A Program Manager's Guide to*

Buying Performance, November, 2001 published by the Defense Acquisition University, "Performance-Based Logistics (PBL) is DoD's [Department of Defense] preferred approach for implementing product support. The PBL is a strategy for weapon system life cycle support that brings higher levels of system readiness through efficient management and direct accountability" (p. 1-4). The majority of PBL initiatives are contracts to a single private company. The overall goal of PBLs is to optimize system readiness. The contractor is required to meet support goals for a weapon system by establishing a support structure based on performance metrics with clear lines of authority and responsibility. The contractor performs logistics functions that have been historically performed by government personnel while implementing best commercial principles and practices.

The inherent disadvantage of PBLs, as often implemented, is that they do not combine the support benefits already in place within DoD. PBL contractors are required to fully and independently develop a supply chain management network to support weapon systems without relying on current support systems already in place within the government. This often leads to the creation of dual support infrastructures, unnecessary costs being assumed by the contractor, and a negative impact on small businesses. These and other disadvantages are overcome by the development of public and private partnerships in the support of PBL contracts.

Therefore, in addition to maintaining a level of performance and implementing commercial supply chain management best principles and practices, the PBL contractor is also required to perform materiel management, distribution, technical data management, cataloging, and contracting functions in obtaining and providing parts support.

This article examines two PBL partnerships that have been developed between the Defense Logistics Agency (DLA) and two PBL contractors; whereby, DLA has become a source of supply for consumable parts in support of the weapon systems under each PBL contract. The lessons learned from these partnerships are presented to illustrate the resulting positive impact in improving weapon system readiness and in reducing overall costs. These reduced costs are ultimately passed on to the Military Service activity awarding the PBL contract.

TWO PBL EXAMPLES

While PBL contracts require contractors to perform an array of services to improve weapon system readiness, these services are often centered around providing materiel within specific timeframes to ensure parts are readily available to ensure weapon system performance. This materiel includes both reparable parts (historically managed by Military Service Inventory Control Points) and consumable parts (historically managed by DLA). Therefore, in addition to maintaining a level of performance and implementing commercial supply chain management best principles and practices, the PBL contractor is also required to perform materiel management, distribution, technical data management, cataloging, and contracting functions in obtaining and providing parts support. These later logistic functions are inherent in the mission of DLA. In the providing of consumable parts support, the contractor is required to both duplicate and improve support historically provided by DLA. Thus results the aforementioned disadvantages of PBLs by creating dual systems of management by ignoring the capabilities already available in the public sector. The two PBLs analyzed in this study illustrate how these disadvantages can be overcome.

From the Navy's standpoint, the contractor has the ultimate responsibility in providing total supply chain management support.

The Navy awarded a PBL contract to Lockheed Martin in support of the S-3 aircraft. Lockheed Martin subcontracted materiel support to Logistics Services International (LSI) as a third party logistics (3PL) parts provider The Navy also awarded a repair contract to Pratt and Whitney in support of the J52 engine. Although repair contracts do not have requirements as extensive as PBLs, they share many of the similarities and require contractors to perform many of the same functions as PBL contractors. A full PBL contract is expected to be awarded for the J52 once the repair contract is completed, to include extended services and materiel support. In both examples, the Navy has transitioned its reliance on materiel support from historically governmental sources of supply (DLA and Navy organizations) to contractor support. Also in both cases, DLA has established partnerships with each PBL contractor to provide consumable parts. Under the S-3 PBL, DLA provides support for 1,087 items. The DLA conducted an initial supply screen of the items, and made advance buys where needed. The PBL vendor was advised of each item's price and stock position in relation to the forecast. Under the J52 PBL, DLA provides support for 161 items. The DLA competed to become a qualified source for the items based on

quality, delivery, and performance standards. In both cases, parts were prepositioned based on where the actual work was being performed by the PBL vendor.

Although each of these PBL contractors obtains consumable parts support from DLA, they are in no way relieved from the contractual performance requirements in their respective contracts with the Navy. From the Navy's standpoint, the contractor has the ultimate responsibility in providing total supply chain management support. They are also still held accountable for establishing the most effective and efficient cost structure to meet the needs of the government. The DLA must then compete as a source of supply and proves its ability to provide support to the PBL contractor that will fit within this efficient cost structure. Accomplishing this is a challenging task that has resulted in the Agency itself becoming more effective and efficient in performing its historical duties as a manager of consumable parts and providing services connected to providing materiel. The following eight lessons learned from both of these examples illustrate the advantages of DLA and PBL contractors establishing partnerships to support PBL initiatives. These partnerships are instituted via of Memorandums of Understanding (MOUs) or Performance-based Agreements (PBAs) that outline the terms and conditions that each party will adhere to (a sample is provided in Appendix A).

LESSONS LEARNED

1. **Creates Partnering versus Dual Infrastructures**—With PBLs where the vendor does not partner with DLA to obtain consumable support, the contractor must establish partnerships with other contractors to obtain parts, personnel to manage the acquisition process, and even a distribution network to store and move materiel. Under the S-3 and J52 PBLs, the vendors simple identify their requirements to DLA. DLA's personnel fill the requisitions, establish long-term agreements with commercial vendors, and DLA already has a worldwide storage and distribution network in place. To ensure that the contractor is able to meet the requirements outlined in the PBL contract, the contractor and DLA partner on sources of supply and forecasting, and DLA sets performance standards compatible with those in the PBL contract. While these performance standards vary per each PBL agreement, some examples include ensuring parts availability between 90 percent and 100 percent, ensuring 100 percent adherence to quality standards, and processing and shipping materiel within 24 hours.

2. **Reduces Materiel Costs**—Many of the items used on the S-3 and J52 are also used on other weapon systems, both within the Navy and on systems belonging to the Air Force and Army. Because DLA buys these parts in volume to support its customers across the Department of Defense, it can obtain much better prices than a single PBL vendor purchasing small quantities of materiel in support of a single PBL initiative. DLA is also able to obtain parts cheaper than PBL contractors because it has established long-term agreements in place with parts providers.

These agreements leverage the buying power of DLA across the entire population of National Stock Numbers (NSNs) on these long-term contracts, leading to cheaper prices for each individual item. Since these agreements are put in place for up to ten years, lower prices are maintained over long periods of time. For example, over the past year the total price for the items used on the J52 PBL has decreased by 4.78 percent. Lastly, DLA's price encompasses the entire cost of maintaining a complete supply chain, from initial cataloging through distribution. Unlike customers that rely on a single contractor for total support, DLA's customer are charged prices for materiel that are not affected by shifts in personnel or other changes in infrastructure due to varying customer demands because of DLA's ability to absorb these variations.

3. **Holds DLA More Accountable**—In supporting the S-3 and J52, DLA can be held to concrete parts support and performance requirements because the PBL vendor is required under the PBL contract to definitively define their requirements. In order to maximize efficiency and minimize costs, PBL contractors must only forecast and order what they actually need. Any overages will result in excess costs that cannot be recouped, and any forecasts below what is needed will result in the contractor not being able to meet the terms of the contract, thus being subject to monetary penalties from the Military activity that awarded the PBL contract. With more accurate forecasts, DLA is able to procure materiel in advance of the contractor's need and even preposition materiel at or near the point of use. The PBL contractor minimizes costs by not having to assume any costs until they actually requisition the materiel for point of use consumption.

4. **Enhances Commercial Partnerships**—The DLA has developed Strategic Supplier Alliances with both Lockheed Martin and Pratt and Whitney (copies of the *DoD Strategic Supplier Alliance Project Guidebook* and DLA Strategic Supplier Alliance (SSA) charters can be found at http://www.dla.mil/j-3/j-336/logisticspolicy/j-3312/webpage%20ssa.htm). These alliances are strategic partnerships whereby NSNs

TABLE 1. DEFENSE LOGISTICS AGENCY (DLA) STRATEGIC SUPPLIER ALLIANCE (SSA) PARTNERS

DLA Aviation Strategic Supplier Alliance (SSA) Partners	
Lockheed Martin	Moog Inc.
Pratt and Whitney	Aircraft Braking Sysytems
Boeing	Canadian Commercial
Hamilton Sundstrand	Eaton Corporation
Parker Hannifin	Rolls Royce
Goodrich Corporation	Sikorsky
Textron/Bell Helicopter	BAE Systems
Northrop Grumman	General Electric
Honeywell	

managed by DLA that are solely sourced from these vendors are placed on long-term corporate contracts with performance metrics. The Navy, Army, and Air Force may also join these partnerships and add their managed NSNs to the alliance as well.

For example, the Air Force has partnered with DLA in the SSA with Pratt and Whitney. By including PBL partnerships under the umbrella of the alliance, the partnership between the government and private enterprise is further strengthened by broadening the government's buying power with each alliance partner. Including Lockheed and Pratt and Whitney, DLA has established 17 SSAs with its top 20 Aviation suppliers (see Table 1 for complete list). Almost 30,000 items are under long-term contracts with these suppliers. These are the same vendors that are being awarded the majority of PBL contracts for aviation systems by the Military Services. These partnerships further enable DLA to leverage its buying power in support in PBL initiatives across all of these contractors and their individual divisions.

Of the 1,248 NSNs collectively being supported under the S-3 and J52 PBLs, almost 800 are provided by DLA's SSA partners.

Other alliances have been established for DLA's top suppliers of parts for its Land and Maritime customers. Of the 1,248 NSNs collectively being supported under the S-3 and J52 PBLs, almost 800 are provided by DLA's SSA partners. The remaining population of NSNs are predominantly competitive items (multiple sources) and thus cannot be added under SSA arrangements, but many are also supported by other types of long-term contracting arrangements.

5. **Gives Customers One Source of Supply**—As stated earlier, the PBL vendor is not relieved from the performance metrics outlined in the PBL contract, even when they use a government supplier to obtain materiel. Therefore, the Navy still ultimately obtains integrated support from one commercial entity, rather than a multitude of government and commercial sources. All of the benefits that are obtained from the PBL vendor using DLA as a source of supply are thus passed on to the Navy. If DLA cannot provide parts within the performance parameters, the PBL vendor is free to obtain these parts from commercial sources. This creates a financial incentive for DLA to have parts available to meet the PBL vendor's forecast within specified performance parameters in able to remain a viable source of supply. With the J52 PBL, DLA's performance in providing parts has surpassed the performance metrics outlined in the PBL contract.

6. **Increases Availability of Parts**—With DLA's SSAs, other long-term agreements and leveraged buying power, the instances of parts availability is greatly increased beyond the availability the PBL vendors would have obtained if they had sought to obtain the parts themselves from the commercial market. The DLA procures its parts from the sources the Military Services dictate. For the collective population of DLA NSNs under the S-3 and J52 PBL, there are over 100 individual sources for these NSNs. If these PBL contractors had not partnered with DLA, they would have had to develop individual partnerships with these vendors rather than simply obtaining support from just DLA.

   On other PBL contracts where vendors have declined to partner with DLA and strictly rely on commercial sources, there have been recurring cases of where they have been unable to obtain parts or have obtained them at prices far greater than DLA's. While these PBL vendors have experienced delays in obtaining parts, DLA has had the materiel readily available. Because the PBL vendor had initially declined to partner with DLA, the stock DLA did have available was procured to meet the demands of its other customers. Providing the materiel to the PBL vendor then creates overall support shortages because of a lack of the PBL vendor's continuous requirements.

7. **Allows PBL Vendor To Focus on Services**—Since the vendors allow DLA to concentrate on providing consumable parts support for the S-3 and J52, they are then free to concentrate their energies on providing enhanced services in other areas. While these vendors have expertise in providing best commercial practices toward repairable parts supply chain management, DLA has expertise in providing consumable support gained from decades of experience. The net effect is utilizing the best of the private and public sector in developing a support system to enhance support to the Navy.

8. **Ensures Survivability of Small Businesses**—Many of the NSNs on the S-3 and J52 PBL have been historically provided by small businesses. Over the past two years, small businesses have been awarded $7.7 million in contracts from DLA from this population of items. While DLA is mandated to ensure that these items are procured from small businesses in order to ensure the survival of these businesses, PBL contractors are not held to the same federal small business requirements and goals as DoD agencies. Obtaining consumable parts support from DLA ensures that small businesses do not lose a substantial portion of their income, as has been the case with other PBLs where the vendor has declined to obtain parts from DLA. By ensuring these small businesses remain viable sources, DLA is also ensuring there is an active industrial base for future support.

SUMMARY

The above lessons learned outline the benefits of PBL vendors partnering with DLA in providing support to weapon systems under PBL contracts. The elimination of dual infrastructures, reductions in materiel costs, increased government accountability, enhanced commercial partnerships, a single source to the Military Service, increased parts availability, and increased focus by the PBL vendor and benefits to small businesses have all contributed to the success of enhanced support to the J52, S-3 and other PBLs where DLA has partnered with private companies.

The Military Services are also recognizing the benefits of these DLA/private company partnerships and are including DLA personnel on their Planning and Intergrated Process Teams as they expand the use of PBLs to enhance weapon system support. Weapon system Program Managers and acquisition personnel should engage DLA early in the planning process to fully understand what benefits DLA can offer. DLA is able to tailor many of its services to the individual needs of each PBL support program. The PBL contractors should also engage DLA early in the PBL process, and even to outline what support will come from DLA as part of their responses to PBL solicitations. As discussed in this article, integrating the best of the public and private sector produces benefits to all parties involved and specifically improves the ultimate support to the warfighter.

Glenn L. Starks, Ph.D., is Chief of the Planning and Requirements Division at Defense Supply Center, Richmond, VA. He has oversight of development and tracking of strategic initiatives that enhance support to the Aviation customers of the Defense Logistics Agency, including Performance-Based Logistics initiatives. He holds a bachelor's degree in business administration, a master's degree in management, a master's certificate in project management and a Ph.D. in public policy and analysis.

(E-mail address: glenn.starks@dla.mil)

AUTHOR BIOGRAPHY

APPENDIX A

SAMPLE MEMORANDUM OF UNDERSTANDING DEFENSE LOGISTICS AGENCY AND PBL VENDOR

This Memorandum of Understanding (this "MOU") is made and entered into as of the 1st day of ______________ (the "Effective Date"), by and between **PBL VENDOR NAME** and the Defense Logistics Agency (DLA), either or both of which may be hereinafter referred to as the "Party" or the "Parties," respectively.

I. PURPOSE

In accordance with Contract ______________ between **PBL VENDOR NAME** and the Military Service, **PBL VENDOR NAME** is authorized to obtain parts from DLA to support the **weapon system(s) name**. The purpose of this MOU is to confirm a basic understanding of the Parties regarding the process of **PBL VENDOR NAME** providing a forecast and ordering the parts and DLA providing the parts.

II. TERM

This MOU shall commence as of the **Effective Date** and terminate only at the convenience of both Parties or the expiration of Contract ______________, whichever occurs first. Termination intent between DLA and **PBL VENDOR NAME** before the expiration of Contract ______________ will be communicated in writing. Upon termination, both Parties unconditionally waive any charges against either Party because of termination of the MOU and release each other from all obligations under the MOU.

III. ORDERING

Per the terms of the Contract ______________, all requisitions submitted to DLA will be done via Military Standard Requisitioning and Issue Procedures (MILSTRIP) or via the DoD Electronic Mall (EMALL). Requisitions may be submitted via automated requisitioning processing through DoD MILSTRIP automated routing, or directly to DLA Inventory Control Points (ICPs) via telephone, fax, or mail. DLA agrees to provide **PBL VENDOR NAME** any training needed on the DoD MILSTRIP or EMALL requisitioning process. A valid Department of Defense Activity Address Code (DoDAAC) will identify all requisitions submitted by **PBL VENDOR NAME** as identified for use by **PBL VENDOR NAME** from the Military Service(s). **PBL VENDOR NAME** agrees that all materiel provided by DLA to **PBL VENDOR NAME** in support of Contract ______________ will only be used in the providing services and parts support under this bilateral basic ordering agreement. DLA will provide parts purchased from approved sources per the Military Service Engineering Support

Activity. DLA will process requisitions received in accordance with MILSTRIP prioritization policies with adherence to DoD's Uniform Material Movement and Issue Priority System (UMMIPS) timeframes based upon the requisition priority, at a minimum.

IV. PROCESSING ORDERS

DLA agrees to process all requisitions received in the most expeditious manner possible. DLA will track these requisitions from the date of submission to the date of shipment, and provide requested status of these requisitions within 24 hours. If stock is not immediately available to fill the requisition from stock on hand or via contract with another entity, DLA agrees to expedite delivery of materiel for delivery to meet Military Service requirements for materiel ordered under Contract ________________ subsequent to a review and agreement on any additional charges that may result. DLA agrees, whenever possible and based upon cost and demands from other users, to position stock for the most expeditious delivery to the end user. This may involve positioning materiel from current depot locations or outlining shipping instructions in contractual agreement terms with vendors.

V. TRAINING

DLA agrees to provide **PBL VENDOR NAME** access and training to DLA inventory systems for the purposes of requisition submission, status, tractability, and inventory visibility. All access and training provided are subject to DoD security requirements.

VI. INFORMATION SHARING

In support of this PBL, **PBL VENDOR NAME** and DLA agree to share information to enhance the long-term support of the Military Service. **PBL VENDOR NAME** will provide a quarterly forecast (March, June, September, December) to DLA.

VII. CHANGES

Both Parties will review this agreement at least annually, and both Parties can make modifications at any time upon agreement. Any agreements made outside of the terms stated within this agreement are only effective upon modification, issuance, and signature of a revised MOU.

VIII. CONFIDENTIALITY

Any confidentiality obligation will be established in a separate Proprietary Information Agreement ("PIA"). The PIA shall survive any termination or expiration of this MOU and remain in full force and effect.

IX. RELATIONSHIP OF PARTIES; NO RIGHTS CONFERRED

Nothing in this MOU shall be construed as giving rise to a relationship among or between the Parties of prime contractor and/or sub-contractors, employer and employee, partners, agency, or joint venturers. Nothing contained in this MOU shall be construed as:

1. Granting or conferring any right to use any information or know how that a Party shall elect to furnish hereunder except as expressly authorized in this MOU; or

2. Conferring any license or right with respect to any trademark, trade or brand name, the corporate name of either Party hereto or the corporate name of a subsidiary of either Party hereto or of any other name or mark or any contraction, abbreviation, or simulation thereof.

X. COUNTERPARTS

This MOU may be executed in one or more counterparts, including by facsimile, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

IN WITNESS WHEREOF, the Parties have caused this agreement to be duly executed by their authorized representatives.

PBL VENDOR NAME	Defense Logistics Agency
By: ______________________	By: ______________________
Name: ______________________	Name: ______________________
Title: ______________________	Title: ______________________
Date: ______________________	Date: ______________________


CONTRACT
AGREEMENT

PERFORMANCE-BASED SERVICE ACQUISITION (PBSA), A-76 AND PERSONAL SERVICES—A CAUTIONARY NOTE

EDWARD ALLEN FRIAR

The concurrent emphasis on acquiring services using Performance-Based Service Acquisition (PBSA) and the new A-76 competitive sourcing procedures gives rise to some potentially conflicting goals that acquisition personnel need to be aware of in order to avoid personal service contracts. A contract for services can become a personal services contract either by the way it is written or by the way it is administered, but proper training and planning can help avoid this pitfall. Acquisition and contracting personnel need to be informed about what constitutes personal services and aware of this limitation as it applies to managing PBSA contracts. This article seeks to further define personal services and offers some suggestions for consideration when writing a performance work statement (PWS) or statement of objectives (SOO) for a PBSA.

The Department of Defense (DoD) now buys more services than goods and this trend is expected to continue into the foreseeable future (Gansler, 2001). All executive departments are required to use Performance-based Service Acquisition (PBSA) to the maximum extent when acquiring services (Federal Acquisition Regulation [FAR], 2004, 37.102, p. 831). The President has directed all executive departments to contract out commercial services using the Office of Management and Budget's (OMB) Revised Circular A-76, May 29, 2003, which outlines procedures designed to subject commercial activities performed by government

personnel to the forces of competition thereby ensuring taxpayers get maximum value for their tax dollars (Office of Management and Budget [OMB], 2003). As of 2003, more than 850,000 government jobs have been identified under the Federal Activities Inventory Reform (FAIR) Act as commercial.

The Federal Acquisition Regulation (FAR) at Part 37.104 has long prohibited personal services contracts, and the previous Circular A-76 also stated that the Circular "did not authorize contracts which establish an employer-employee relationship between the government and contractor employees," i.e., personal services (OMB, 1983, Para. 7(c) (5)). This language has been removed from the revised Circular A-76, but any contract awarded as a result of this process would still be covered by the FAR, which prohibits personnel services contracts. Now with the increasing emphasis on competitive sourcing of government jobs using perfomance-based contracting methods that allow only the statement of the outcome or goals to be achieved under the contract, there is an increased potential for violating the prohibition against contracting for personal services. Acquisition and contracting personnel need to be informed about what constitutes personal services and aware of this limitation as it applies to managing PBSA contracts.

Now with the increasing emphasis on competitive sourcing of government jobs using performance-based contracting methods that allow only the statement of the outcome or goals to be achieved under the contract, there is an increased potential for violating the prohibition against contracting for personal services.

According to FAR 37.104, "personal services contracts are characterized by the employer-employee relationship they create between the government and the contractor personnel" (FAR, 2004, 37.104(a), p. 832). "Agencies of the federal government are not allowed to award personal services contracts unless specifically authorized by statute (5 United States Code [U.S.C.] 3109) to do so" (FAR, 2004, 37.104(b), p. 833). But what actually constitutes an employer-employee relationship and thus personal services? The FAR says an employer-employee relationship is created when the service contract's terms, or the manner of the contract's administration, subject contractor personnel to relatively continuous supervision and control of a government officer or employee. Merely ordering a specific performance or result, with the right to accept or reject the work, is not that type of supervision (FAR, 2004). Each contract is to be judged on its own merits

with the primary question being: Will the government exercise relatively continuous supervision and control over contractor personnel performing the contract (FAR, 2004)?

In FAR 37.104(d) there are some descriptive elements that should be used in assessing whether or not a proposed contract is for personal services, these include:

1. Is performance on site? (i.e., on a Government Installation)

2. Are the principal tools and equipment furnished by the government?

3. Are the services being performed by the contractor directly related to the accomplishment of the agencies assigned mission or function?

4. Are comparable services being performed in the same agency by civil service personnel?

5. Will the need for this type service be expected to last beyond 1 year?

6. Does the nature of the service being provided reasonably require government direction or supervision of contractor employees in order to adequately protect the government's interest, retain control of the function involved, or retain personal responsibility for the function by a duly authorized Federal officer or employee? (FAR, 2004, 37.104(d), p. 833)

If you have a services contract with some of these elements then you potentially have a personal services type contract. You need to proceed with caution, re-evaluate your performance work statement (PWS) or statement of objectives (SOO) to ensure that government personnel will not be directing or supervising contractor employees in order to accomplish the contract performance requirements. In 1999, the General Accounting Office (GAO) denied a protest from Encore Management Company (see B-278903.2) over the cancellation of a solicitation for clerical and administrative support services where the government agency's actual requirement was for personal services. As stated in the decision, "Although the incumbent contract started off small and included temporary, short term positions for a limited portion of the agency, the requirements quickly grew into requirements for permanent clerical and administrative positions throughout the agency. The contractor's personnel in these positions worked at the agency's offices alongside government employees performing the same or similar work and using government supplies and equipment. Government managers supervised contractor personnel by directing, reviewing, and approving their work" (GAO, 1999, p. 4).

The GAO went on to say that cancellation of this solicitation was reasonable and proper because, "the agency no longer needs temporary personal services for short term positions; rather, the only purpose of this contract is to satisfy the agency's needs for full time permanent staff" (GAO, 1999, p. 4). The point here is that simply because an agency has a need for additional manpower that is commercial in nature does not relieve the agency from the prohibition on contracting for personal services.

Although, the new A-76 process does not specifically prohibit the awarding of personal services contracts, the implication would seem to be that *personal services* would not be permitted unless they fall under one of the exceptions allowed in the FAR or in other law. It is up to the contracting officer and performance work statement team to ensure that the PWS/SOO does not contain personal service requirements. Contracting personnel should use the guidance in FAR 37, as discussed above, in determining if the solicitation contains requirements for personal services. If it does, they should be deleted or rewritten to make them non-personal services.

For example, in a recent opinion by the Chief Counsel of the Legal Office, U.S. Army Communications and Electronics Command (CECOM), it was determined that, "it appears that contracting for administrative or secretarial services traditionally provided by the Legal Office support staff would be difficult since obtaining those services from contractor personnel without relatively continuous supervision does not appear feasible" (Szymanski, 2001, p. 5). Not only would the inherent nature of this service require *continuous supervision*, but this is an on going requirement expected to last more than one year, the work would be performed on-site, the principal tools and equipment would be furnished by the government, and comparable services are performed in the agency using civil service employees. A-76 is about competitive sourcing not about filling government employee's chairs with contractors.

A-76 is about competitive sourcing not about filling government employee's chairs with contractors.

Although it may seem fairly straight forward to determine if a service is personal or not, that is only half of the problem. The other half that needs to be considered is how the contract will be administered. The best written performance work statement for non-personal services may be converted to personal services by the way the contract is administered. As indicated above in the Encore Management case, when the government, during contract administration, directs or supervises contractor employees over a sustained period of time, a personal service contract may be formed. According to Steven Schooner, at George Washington University Law School, this has been a problem in another way; "workforce reductions and outsourcing pressures have conspired to increase the government's reliance on personal services contracts, under which the government retains the function, but the contractor employees staff the effort. Under such contracts rather than using a performance-based approach, agencies all too often merely purchase labor" (Schooner, 2004, p. 73).

As competitive sourcing continues, and even accelerates, it is sometimes easy to forget that replacing government workers with contractors means more service contracts and good service contracts have historically been hard to write (Schooner, 2004, p. 70).

However, as Mr. Schooner has also pointed out, "Competitive sourcing depends on skilled professionals planning, competing, awarding, and managing sophisticated long term service contracts. But despite mandates to contract out government functions, the administration placed no concurrent emphasis on retaining or obtaining suitable acquisition personnel" (Schooner, 2004, p. 73). In fact, at the same time agencies are being told to complete more jobs they are also being told to use performance-based contracting for acquiring these services with no subsequent increase in training or personnel.

The principal objective of PBSA is to state the government's requirements in terms of performance objectives or outcomes desired rather than the method to be used in performance.

The principal objective of PBSA is to state the government's requirements in terms of performance objectives or outcomes desired rather than the method to be used in performance. The problem here is that this is easier said than done. Acquisition personnel need experience and training in order to write effective PWSs, and many times a team may only work on one A-76 study in their career. In a 1999 study entitled, *A Plan to Accelerate the Transition to Performance-based Services,* Frank Anderson, now President of the Defense Acquisition University (DAU), recognized that, "All participants in service acquisitions including the requirements developers, the contracting personnel, the program manager and the quality assurance and contract administration personnel should be involved in team structured training" (Anderson, 1999, p. 47). Training may indeed be the key to successful performance-based service contracting, and the earlier in the process they get this training the better. Both DAU and the Army Logistics Management College (ALMC) now offer training in PBSA. To find out more about this training you can go their Web sites at www.dau.mil or www.almc.army.mil. Other government agencies, the National Contract Management Association (NCMA) and a number of private sources also offer training in PBSA.

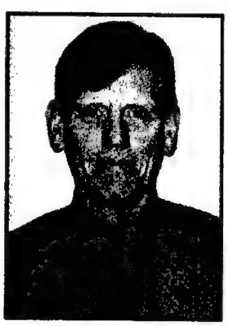
The PWS is the foundation on which effective and efficient contract performance is built, and writing a good one is not easy. Training and experience can obviously help in this process, and there are a number of online resources as well as formal classes available. Here are some suggestions taken from the Defense Logistics Agency's (DLA) *Commercial Activities Guidebook.* The PWS should describe all requirements that must be met in clear concise wording. Key elements of the a PWS include a statement of the required services, where performance is to take place, the period of performance, measurable performance standards, and the acceptable quality level or allowable error rate (Defense Logistics Agency [DLA], 2004, pp. 5-4, 5-5). The PWS

will become Section C of the solicitation and should also include general information the contractor needs to know, Government Furnished Property (GFP) or services that will be provided, and quality control requirements. The PWS team will also develop a Quality Assurance Surveillance Plan (QASP) that describes the procedures the government will use to monitor contract performance. The primary focus of the QASP is to ensure the service provider's quality control program is working and that they are meeting the requirements of the PWS. Quality management responsibility is on the service provider not the government. The government should be primarily concerned with checking the service provider's quality control program.

Although the PWS team usually writes the PWS, the contracting officer is ultimately responsible for it. They should ensure that the services are not personal, that the services can be procured in the market, and the contract can be administered so that government direction or supervision of contractor employees will not occur. They also should ensure the involvement of the PWS team including the requiring activity and the competitive sourcing official in the final review of the PWS (DLA, 2004, p.5–5, 5–6).

With the confluence of PBSA and the new A-76 competitive sourcing initiatives, the need for team training is more important than ever to insure that the objectives of one program do not override the requirements of the other. It is also important to understand, as stated in step seven of *Seven Steps to Performance-based Services Acquisition*, "there is a growing realization that the 'real work' of acquisition is in contract management" (Office of Federal Procurement Policy [OFPP], 2004, p. 37). In service acquisition, contract management is a "mission critical agency function" (OFPP, 2004, p. 37).

For this reason, the acquisition team should be organized early, represent all interested parties, be trained and motivated to have a successful contract. Although it is hard for contracting people to swallow sometimes, there is some truth to the statement that, "Contract award is not the measure of success or even an especially meaningful metric" (OFPP, 2004, p. 38). Effective and efficient contract performance is the true measure of a successful contract—and this success, to a large extent, depends on the experience, training, and motivation of the acquisition workforce.



Edward Allen Friar is a Professor of Contracting at the Defense Acquisition University-South in Huntsville, AL. Friar has over 15 years contracting experience with the U.S. Army including the U.S. Army Aviation and Missile Command at Redstone Arsenal in Huntsville. Mr. Friar received his master's degree in Public Administration (MPA) from Arkansas State University and his bachelor's degree in Political Science from Southwest Missouri State University.

(E-mail address: allen.friar@dau.mil)

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CONTRACT ADMINISTRATION IN A PERFORMANCE-BASED ACQUISITION ENVIRONMENT IS SERIOUS BUSINESS

JOHN CAVADIAS

Many of us are eager to implement Performance-Based Services Acquisitions (PBSA) as we attempt to comply with procurement and acquisition reform. Although there is an abundance of written material instructing us on how to develop and award a PBSA, we find far less guidance on the emerging realities in administering an awarded PBSA. Contract administration in a PBSA environment is mission-critical, not to be treated as an ancillary responsibility subordinate to originating acquisitions. This article approaches this viewpoint by examining the post-award management of a single service in one commercial industry and compares it to government contracting practices particularly with an emphasis on legacy cradle-to-grave organizational structures while also exploring the need for a shift in government perspective and change in organizational practices.

Increasing the use of Performance-based Services Acquisitions (PBSA) to 40 percent of eligible service actions over $25,000, during fiscal year 2005, is the target achievement level for all federal government contracting offices procuring services (Office of Management and Budget [OMB], 2004). Regardless of what agency, which contracting command, or the size of the contracting office, acquisition reform

applies to all those in the business of procuring and administering services in the federal government. As agencies begin to develop their management plans for the Office of Management and Budget (OMB) outlining their approach to increase the use of PBSA, it is crucial that agencies give considerable attention to managing the post-award contract administration phases just as they will do so with pre-award planning.

Several military components within the Department of Defense (DoD) pass their contract administration functions onto the Defense Contract Management Agency (DCMA) for post-award execution. Not all contracting offices, however, can assign their contracts to the DCMA for contract administration. It is clear that the DCMA does not engage in garrison contract management. The responsibility of that function usually falls to the installation or tenant commander if the contract is for a base, post, camp, or station (Defense Federal Acquisition Regulation Supplement [DFARS], 2001). Moreover, the DCMA must now focus their attention and limited resources on major program efforts and critical readiness items. Accordingly, even a billion-dollar PBSA such as the Marine Corps' (USMC) garrison food service contract is managed at the installation level since it is outside the mission of DCMA (Defense Contract Management Agency [DCMA], n.d.).

Our starting point for discussion begins here, at home base, where we originate our PBSA contracts. After awarding a PBSA, many of us must also face the challenges of administering a contract that demands specialized skills and resources beyond simple contract compliance (Interagency-Industry Partnership in Performance, 2003). Managing performance in a PBSA environment is *a whole new ball game* in the world of government contract administration.

WHO'S ON FIRST?

At contracting offices that manage contracts from inception to closeout—or cradle-to-grave—such as those contracts for base, post, camp and station on military installations, the unwritten prioritized order of work is typically (1) pre-award procurement/acquisition, (2) post-award crisis management, and lastly, (3) post-award contact administration. In these contracting shops, contract administration is given the lowest priority and is sometimes viewed as the necessary evil of the business. This is greatly so because the principal metrics classically established, in order of importance, consist of (1) contract dollars procured, (2) number of contract awards, and (3) procurement administrative lead time (PALT), which is the total time it takes to award a contract—the quicker the better. Conversely, post-award contract administration contributes almost nothing to these three guiding metrics; therefore, it is difficult to justify an investment of labor into a post-award operation that does not point to a visible cost-benefit with regard to these conventional metrics.

This outdated logic can no longer add any value to maintaining an effective program when faced with managing PBSA. We find that PBSA introduces a host of additional

post-award metrics seldom seen within traditional non-PBSA contracting. The standards of measurement in a PBSA become more results-oriented such as quality of work or product, accessibility, timeliness, accuracy, and customer satisfaction. Once performance metrics are defined and methodically developed in the contract formation phase, the acquisition team cannot comfortably disperse immediately after contract award in the assumption that first-rate contract performance will consistently materialize according to plan throughout the execution phase. On the contrary, each member of the team must tirelessly work together managing performance from the point of contract award until contract closeout.

Many commercial industries have long recognized that the servicing or administration arm of their businesses is as mission-critical as their origination or production stage.

PBSA requires a level of commitment and teamwork from all involved that exceeds that required in other types of contracts (Know Net, n.d.). There is no escaping this new reality. The success of a PBSA is highly dependent on the effort and resources invested into monitoring performance by using many sophisticated tools and metrics including performance indicators and standards, quality assurance surveillance plans (QASP), performance requirements summaries (PRS), acceptable quality levels (AQL), and appropriate positive as well as negative incentives. The question is: With essential post-award metrics that carry such heavy consequence, are most cradle-to-grave contracting offices equipped with the resources to manage PBSA in a political environment of federal budget constraints and acquisition workforce downsizing? More important, even if supplied with adequate resources, will the three principal metrics continually eclipse the importance of improving the PBSA post-award metrics? It seems that agencies focus their attention on awarding contracts, not on managing them once awarded (Schooner, 2004).

Today in this burgeoning PBSA environment, the agencies' needs for contract oversight are expanding, not decreasing. Thus, contract performance management urgently requires an infusion of investment into post-award contract administration operations. Many commercial industries have long recognized that the servicing or administration arm of their businesses is as mission-critical as their origination or production stage. This article includes discussions of one such industry to illustrate the vital importance of managing a business with adequate and specialized resource allocation among all operational phases and the consequences if neglected.

WE CAN ALL LEARN FROM INDUSTRY

The Under Secretary of Defense had stated, "PBSA strategies strive to adopt the best commercial practices...to achieve greater savings and efficiencies" (Department of Defense [DoD] Acquisition and Technology, 2001, p. 1). We can safely presume that this announcement not only applies to the acquisition planning, contract formation, and source selection phases, but also to the execution management phases of a PBSA.

Contract administration is rather analogous to the loan servicing operation within the mortgage banking business, a commercial industry to which most homeowners can relate. We might be able to use some of the same lessons from the mortgage business as we view the business of government contract administration. To illustrate this analogy, let us follow the phases of how a loan is originated and subsequently administered once the loan is funded, a process that is similar to procuring and administering a contract.

When a financial lending organization receives a requirement for a mortgage loan, it goes through a phase akin to tasks performed in government acquisition planning. The processing of a loan will include completing a requirements analysis; credit analysis, employment verifications, and property appraisals; methods of financing; and pricing arrangements. In government contracting, these tasks are respectively parallel to developing an acquisition plan and performance work statement; past performance review; determining contractor responsibility; contracting methods; and choosing a contract type. Once completed, the processed loan package will progress onto a warranted loan officer for underwriting, not unlike the contract formation phase, where the pre-award package undergoes a final review to ensure it conforms to all required guidelines.

Contract administration is rather analogous to the loan servicing operation within the mortgage banking business, a commercial industry to which most homeowners can relate.

Finally, the loan package is closed, official documents are drawn, and the loan is awarded and funded to the holder of the new mortgage (borrower). Throughout this process, a lender must abide by hundreds of statutes, regulations, and guidelines, similar to government contracting under the Federal Acquisition Regulations (FAR) and its supplements. There are also socioeconomic considerations the lender must heed throughout all phases. In the lending business, these pre-funding stages are referred to as loan origination.

Once a lender completes the loan origination stage, the funded mortgage loan is usually sold to investors via the secondary markets, e.g., Ginnie Mae. Most borrowers never realize that their loan contract is sold to outside investors since the transaction is transparent. For the government, they too have their own group of investors who fund acquisitions—the American taxpayer.

The final and longest phase in the life cycle of a loan contract is known as loan servicing where it is administered. Lenders have the choice of either outsourcing this part of the operation or retaining the servicing operation in-house. Regardless of whether servicing is released or retained with the original lender, this subsequent post-funding stage is where the real work begins. Here, dozens of crucial administration tasks must be implemented and monitored throughout the life of the loan contract.

For the government, they too have their own group of investors who fund acquisitions—the American taxpayer.

Loan origination might have taken only a matter of weeks or a few months from requisition to award. However, in the succeeding loan-servicing phase, a single loan contract requires years of administration—five to seven on average but can go beyond 30. In this multifaceted administration phase, a collaborative team of skilled professionals engages in a form of daily performance monitoring adhering to a clear set of standards and metrics. The loan-servicing workforce required to run such a post-award-like operation is sizeable, diverse, and specialized. Their positions include customer service representatives; quality assurance specialists; escrow/impound analysts; government compliance and reporting specialists; risk investigators; debt collectors; default appraisal managers; bankruptcy and foreclosure specialists; and investor accountants, among others.

WE CAN ALL SUFFER FROM POOR ADMINISTRATION

Can you imagine the harmful consequences to the lender if insufficient, scattered, or unspecialized resources were assigned to managing the post-funding phase of lending? Perhaps a borrower would discover that his property tax bill was paid late through negligence by the loan servicer, resulting in losing their property through a tax sale. How might the financial fate of the investment in the loans change if the lender stopped investing adequate resources toward executing vigilant post-funding oversight? Perhaps property insurance analysts would neglect to check whether mandatory fire insurance premiums are paid. If true, then lender's collateral guaranteeing the loan contract would be at high risk of total loss should it burn down.

Other ensuing scenarios might include losses from abandoning fiscal management oversight. Without properly monitoring the aging of mortgage accounts, debt collections would never begin, as no one would know which borrowers are delinquent. In turn, a high percentage of the loan portfolio would increasingly fail as revenues from monthly mortgage payments decrease or discontinue all together. Delinquent borrowers that could have been salvaged by debt collectors at the early stages of default via informal remedies now would find themselves beyond the point of recovery. Homes that should have been foreclosed long ago would turn into rent-free dwellings. Private and public investors in these now deteriorating mortgage portfolios would risk losing a considerable portion of their financial investment. In short, without the essential resources fully employed in post-award administration, results would turn disastrous for all the parties.

Poor performance monitoring, sporadic quality assurance, little effort expended into managing changes or settling disputes does indeed result in damages to both government and contractor as it does with producer and consumer.

Similar consequences can occur with inadequate resources in government contract administration. Poor performance monitoring, sporadic quality assurance, little effort expended into managing changes or settling disputes does indeed result in damages to both government and contractor as it does with producer and consumer. Undesirable outcomes from the deficient employment of suitable and adequate resources become highly magnified and perilous in a PBSA environment. Let us now look at a typical contracting office, which is extra vulnerable to finding themselves challenged with PBSA contract administration, such as those offices at the military installation level that are unsupported by the DCMA.

WHAT'S ON SECOND?

In the traditional world of non-performance-based contracting, many awarded service contracts may appear fully automated during its post-award life cycle. Some believe there is no need to shift gears in this post-award phase because it is perceived as self-regulating. The contractor delivers the service, perhaps with only modest issues or few problems along the way. Contract specialists can often get away with ignoring many of their post-awarded contracts, with little consequence, as they work on new procurements until, for example, an option to extend services comes due.

On the surface, ignoring most administration duties usually goes unnoticed. However, when a potentially serious problem does crop up requiring immediate action on the part of the contracting office, the situation quickly becomes a firefight. Fighting fires is second in order of prioritized jobs previously referred to as *post-award crises management*. All business in the pre-award arena must come to a halt as energy now focuses on extinguishing the crises at hand. Once the fire is ostensibly extinguished, it is back to originating new contracts although sizzling embers from those earlier fires may still burn beneath the surface, perhaps waiting to re-ignite.

While the contract administration file often sits in a remote file cabinet, *out of sight, out of mind* becomes more of a standard practice than just a figure of speech. Though supervisory contract specialists practically never encourage this behavior, it is frequently condoned. The underlying reasons are internally evident: metrics. The contract specialist has little time to perform duties perceived as non-critical while continually pressured to rapidly originate more contracts in order to increase the contract dollars procured and number of contracts awarded. Moreover, new requirements must be awarded expeditiously in accordance with another significant metric mentioned earlier, PALT. These are the metrics most often monitored and evaluated by government leaders from supervisory contract specialists all the way up to congressional representatives.

Considering the exposure these metrics receive, it is no wonder that government investment into pre-award contracting activities rises above other competing priorities, most detrimentally above contract administration that appear to carry no worthy metrics. However, there is one worthy metric in contract administration that overridingly seems to capture the attention at the highest levels of government: the media broadcasting of embarrassing news stories whenever contracts fail to self-regulate.

Fighting fires is second in order of prioritized jobs previously referred to as post-award crises management.

The organizational views on contract administration in this cradle-to-grave structure appear to murmur, *No more time than is absolutely required should be devoted to this less visible job*. So in effect, time invested administering contracts equate to time lost procuring new purchase requirements. Therefore, we can infer that performing contract administration in this cradle-to-grave environment emerges mostly as a distraction and a hindrance to the primary goals of the contracting office, which are to procure more contracts to fulfill those highly visible metrics.

Occasionally, many of us do come upon some highly talented contract specialists that are quite masterful at juggling both procurement and administration tasks. Recruiting the finest jugglers into government contracting, however, is not a long-term

or viable solution. The fundamental dilemma does not lie within uncovering and developing the multi-tasking skills of the individual contract specialist. The problem is with continuing to expect optimum results in both procurement and administration from a single, group, or department of contract specialists whose behavior is almost entirely directed by three metrics—dollars procured, number of awards, and PALT. The mind-set that we can *do it all* as we transition toward PBSA contract management must be seriously reconsidered if we are to ensure the highest possible resource utilization and level of success in this emerging world of performance-based contract management.

MANAGE RESOURCE ALLOCATION FOR OPTIMUM RESULTS

Ask yourself as you think back to the loan servicing scenarios presented earlier: Can the loan originators do it all? Can they successfully monitor a diverse portfolio of post-awarded loans as they juggle loan origination efforts to satisfy prospective homeowners' expectations for a quick loan closing? Furthermore, can the debt collectors simultaneously meet the demands for originating new loans as they juggle their loan servicing efforts toward meeting aggressive low-delinquency goals to protect investors? Most would agree it seems unreasonable to expect that such a misallocation of human resources could produce the desired objectives in either the loan origination phase or loan-servicing phase of a lending operation.

Classical economic thinking encourages increasing the division of labor to improve efficiency and growth.

Classical economic thinking encourages increasing the division of labor to improve efficiency and growth. Therefore, it should be recognized by and adapted to contract administration as has always been standard practice in commercial industry. Invest in sufficient human resources and specialize the workforce to the job requirements considering the entire organizational structure and its goals.

CLOSING REMARKS

Managing contracts in today's PBSA environment demands leadership's unwavering commitment to build a contracting organization that will not find their contracting professionals continually divided between chairing a source selection committee and negotiating multi-million dollar equitable adjustments. One priority will forever battle

to overtake another higher, equivalent, or lesser priority. Each phase of contracting is justifiably and distinctly a mission-critical entity that warrants specialized resources. These entities must equally coexist so that competing priorities no longer struggle to survive at the same time, in the same space. Preserving a cradle-to-grave operation under a single edict of three metrics will only guarantee an early grave for acquisition reform.

If we are to ensure that government and contractor both fulfill their contractual obligations under a PBSA, we must invest in the right mix of specialized talent as we undertake these aggressive acquisition reforms. Plan for, invest in, and fight for all the right resources to make your PBSA a total success throughout the entire life of the acquisition. Invest early, discriminately, and prudently, so that we can guarantee that our ultimate investors, the American taxpayers, will continue to reap a meaningful return on their investment in the most productive government in the world.

John Cavadias is the contracting officer for the largest Performance-Based Services Acquisition in the U.S. Marine Corps (USMC). Prior to this assignment, he led formal contracting for USMC's Regional Contracting Office Southwest, which performs cradle-to-grave contracting. He holds an M.B.A. from California State University, San Marcos; a B.B.A. in finance/banking; and recently was recognized by Assistant Chief of Staff (AC/S) Logistics as Employee of the Year for organizing the new contract administration team at Camp Pendleton.
(E-mail address: john.cavadias@usmc.mil)

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TEST AND EVALUATION IN A DYNAMIC ACQUISITION ENVIRONMENT

GREGORY L. BARNETTE

Acquisition reform and the implementation of agile acquisition processes within the Air Force are allowing acquisition professionals greater flexibility in meeting user requirements. A strong emphasis is being placed on using mature systems and technologies, allowing new programs to be initiated at any point in the acquisition process continuum. Changes have been incorporated into the test and evaluation (T&E) process to support the increased flexibility. Judicious use of the various types of recognized tests allow the program manager (PM) to reduce risk and ensure performance expectations are met. The following provides an overview of the test tools available to the acquisition professional and highlights the evolutionary changes that were recently incorporated into Air Force test guidance.

Headquarters Air Force/Test and Evaluation (HQ AF/TE) released a new test and evaluation instruction (Air Force Instruction [AFI] 99-103) on August 6, 2004. The release of AFI 99-103 corresponded with a rewrite of AFI 63-101, *Capabilities Based Acquisition*, April 1, 2004 (interim approval) and AFI 10-601, *Capabilities Based Requirements Development*, July 30, 2004, bringing all the instructions in line with direction found in Chairman Joint Chiefs of Staff Instructions (CJCSIs) 3170.01D (2003), *Joint Capabilities Integration and Development System*, and 6212.01C, *Interoperability and Supportability of Information Technology and Nation Security Systems*. Perhaps more importantly, the new AFI 99-103 (2004) incorporated evolutionary changes, reflecting the test and evaluation community's adaptations to the Air Force's implementation of the agile acquisition processes over the last decade. The instruction also poses a seamless verification process that fosters an integrated testing

philosophy in an effort to streamline Test and Evaluation (T&E), much as the acquisition process itself is being streamlined.

This effort to integrate testing is born out by the fact that the new AFI 99-103 (2004) is itself a compilation of the former AFI 99-101 (1996), *Developmental Test and Evaluation*; AFI 99-102 (1998), *Operational Test and Evaluation*; and AFI 99-105 (1994), *Live Fire Test and Evaluation*. The following shows how the traditional T&E process supports the spiral acquisition philosophy, describes how the types of tests support the new acquisition philosophy, and highlights new test programs that facilitate technology transition to the warfighter.

TRADITIONAL TEST AND EVALUATION SUPPORT FOR SPIRAL ACQUISITION

Though the acquisition process has evolved along with the country itself, the structure for much of the modern acquisition processes was put in place by the McNamara reforms and remains fundamentally unchanged. This was done to reign in a system that was perceived as out-of-control, as evidenced by aircraft cost overruns that were as much as 100 percent after inflation adjustment toward the end of the Korean War (Harman, 1997). Standardized procedures and processes replaced those developed by services and individual program offices. Programs, especially major systems procurements, were expected to adhere rigorously to this process (shown in Figure 1). To progress through

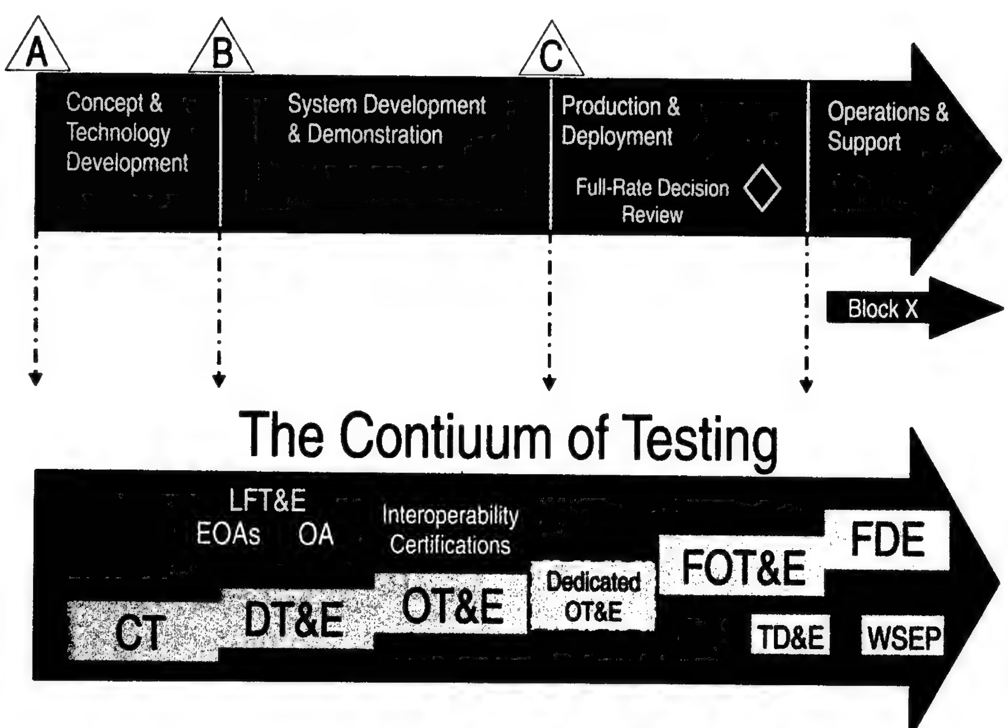

FIGURE 1.
ACQUISITION PROCESS WITH TEST AND EVALUATION TIMELINES

the process, a program had to pass through a series of well-defined gates, designed to minimize risk to the government. The program had to demonstrate its maturity by passing a series of tests at each gate that were designed to ensure the development was progressing adequately. The tests were on a continuum that focused initially on the engineering aspects of the program and shifted later to operational concerns.

Requirements under United States Code Title 10 §2399 (2002) drew a clear distinction between the two types of testing by requiring the user to demonstrate the effectiveness of the final design in an operational environment. This further dichotomized developmental test and evaluation (DT&E), where the acquisition community tested systems and subsystems against engineering and contract specifications, and operational test and evaluation (OT&E), where operators tested the entire systems including its support infrastructure against the mission requirements. This dichotomy was emphasized by the requirement for the DT&E test organization to certify the system as ready for operational testing (see AFMAN 63-119).

The DT&E portion of the test and evaluation process has been inherently more flexible by virtue of having the requirements developed internally to the program office and can correspondingly adapt to the requirements of a spiral acquisition processes.

The DT&E portion of the test and evaluation process has been inherently more flexible by virtue of having the requirements developed internally to the program office and can correspondingly adapt to the requirements of a spiral acquisition processes. The program office's design integrated product team (IPT) is delivered a set of mission requirements for the program, along with any associated key perfomance parameters (KPPs). The design IPT takes the mission-level requirements and develops system design requirements and specifications that are traceable to the KPPs. The program office now has the latitude to select which design requirements and specifications are critical technical parameters (CTPs), subject to the milestone decision authority (MDA) approval (and Office of the Secretary of Defense [OSD] approval for programs on the oversight list).

An example of a KPP and its derived CTPs could be the user requirement for supersonic cruise capability in military power and the respective engineering requirements for a maximum take-off weight and minimum thrust to accomplish this cruise capability. The CTPs normally drive the DT&E test requirements and the program office gets to decide what level and degree of testing is required.

If the contractor test is deemed adequate, data/report review, over-the-shoulder observation, or test participation may be the extent of government involvement. If government testing is required, a DT&E agency will be given the requirements to execute at decision points within the development effort. Since the program office owns the design process, chooses which parameters to track/test, and controls what goes to the DT&E process, their trade space in making those decisions includes impacts due to the DT&E test requirements.

The two biggest changes to the DT&E process stem from the integrated test approach espoused in AFI 99-103 (2004) and the preference to employ combined DT&E and OT&E, whenever practical. Collaboration between the designated OT&E and DT&E agencies has been historically focused on the development of the test and evaluation master plan (TEMP) and preparation for certification for dedicated OT&E. The new requirement to establish an integrated test team (ITT) at the onset of a program will ensure contractor, developmental, and operational testers remaining actively engaged throughout the program. This will assist in obtaining the goal of seamless verification by helping to eliminate duplicate test requirements, correcting scheduling inefficiencies, identifying performance concerns early, and smoothing the transition to dedicated OT&E. An ITT will also facilitate the accomplishment of combined DT&E and OT&E by ensuring OT&E requirements are communicated early and incorporated into DT&E planning.

Numerous failings of critical operation issues (COIs) during operational testing have resulted in decertifying the systems and sending them back into development to correct the deficiencies.

OT&E test agencies have traditionally become heavily involved in active testing following certification for dedicated OT&E. Numerous failings of critical operation issues (COIs) during operational testing have resulted in decertifying the systems and sending them back into development to correct the deficiencies. This has prompted the Director, OT&E (OSD) and HQ AF/TE to push for more active participation by OT&E agencies earlier in the development process. This has led to the implementation of numerous types of user demonstrations that are executed in parallel with the development process, such as Early Operational Assessments (EOAs), Operational Assessments (OAs), and Operational Utility Evaluations (OUEs), which are all authorized under AFI 99-103. Operational testers have also been encouraged to participate in DT&E tests as observers to facilitate early communication. (Note: The legal requirements for operational testing are to support production and fielding decisions at the end of the acquisition process.)

OT&E has begun to have a profound impact on DT&E by program offices implementing combined DT&E/OT&E for cost and schedule efficiencies. Policies implemented as the result of the legal requirement for operational testing preclude contractor participation in the execution of the test (except as planned for in the concept of operations), data collection and analysis by the prime contractor, the use of prototype hardware, use of a non-representative test environment, and changes to the test articles. None of these prohibitions apply to DT&E, but must be observed during combined testing to carry data forward into OT&E analysis.

There are two types of qualification testing: qualification test and evaluation (QT&E), analogous to DT&E, and qualification operational test and evaluation (QOT&E), analogous to initial OT&E.

Air Force 99-series instructions and regulations have historically allowed for the performance of qualification testing. Qualification testing was designed to facilitate procurement of non-developmental items (NDI), ready to be put to use in the Air Force. There are two types of qualification testing: qualification test and evaluation (QT&E), analogous to DT&E, and qualification operational test and evaluation (QOT&E), analogous to initial OT&E. Successful completion of a QOT&E provided results for milestone C entry for a non-developmental item. The availability of QT&E allowed for earlier testing of an NDI system that may require minor modification or perhaps had some issue concerning readiness for QOT&E. The existence of qualification testing demonstrates flexibility in the existing process to support some of the currently touted agile acquisition philosophies. It just lacked the present emphasis.

EVOLUTIONARY TEST TOOLS

One of the primary goals of agile acquisition is to shorten the acquisition cycle time. This can be accomplished by either reducing the time it takes to accomplish the process or by entering the acquisition cycle at a later stage in the process. To accomplish the later, OSD has implemented a hierarchy of solutions for meeting requirements via a new start acquisition program. This directs decision makers to look for solutions where development costs are minimal and design solutions are mature. This hierarchy is listed below in order of descending preference:

1. Use or modification of an existing U.S. system,

2. Use or modification of an existing commercial or allied system,

3. Cooperative development with an allied nation,

4. Joint service development program, and

5. Service-unique development program.

Though the preference for use of existing technologies is clear, there is no direct incentive for their selection. To provide the incentive to use such solutions, both OSD and the Air Force have created special test programs and processes that provide both funding and empowerment. This encourages program offices to select solutions capable of entering the acquisition process at milestone B or C with a demonstrated

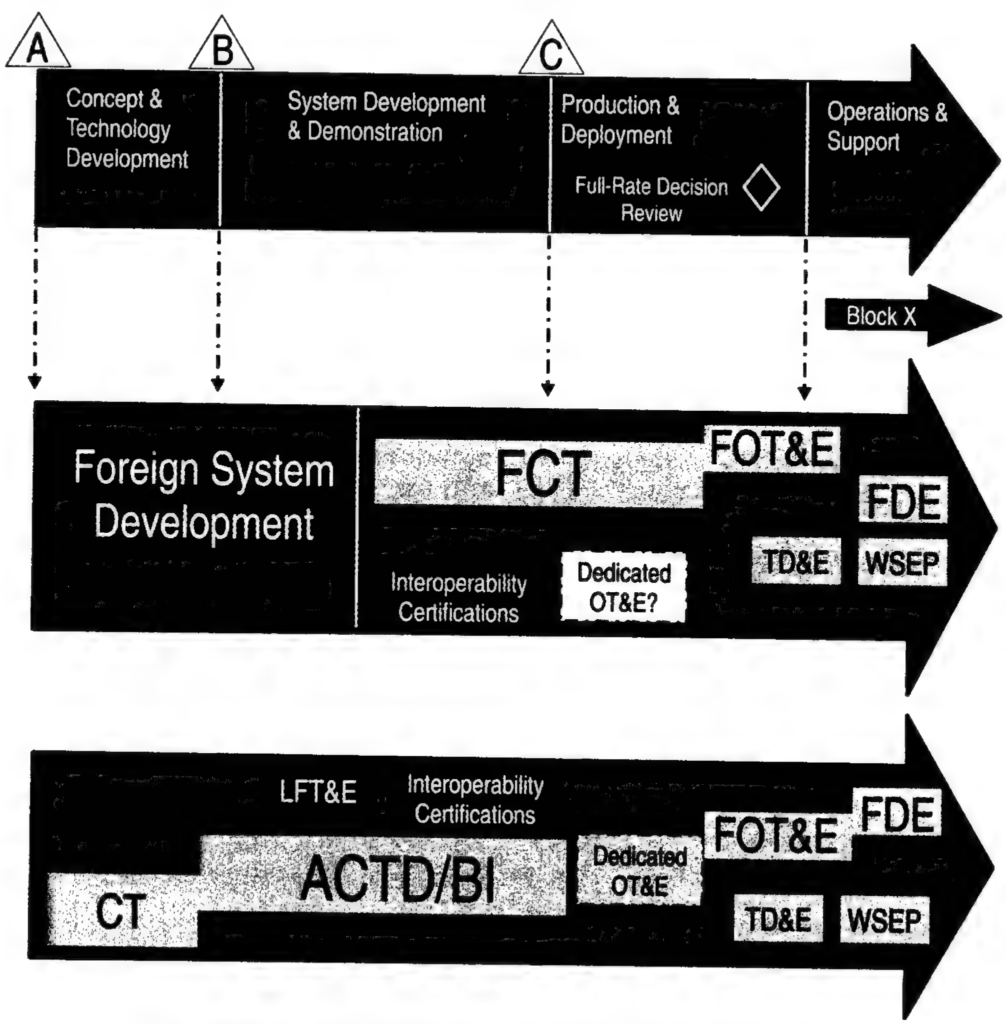

FIGURE 2. EVOLUTIONARY TEST TOOL TIMELINES

system capability. The OSD programs include the Foreign Comparative Test (FCT) and Advanced Concept Technology Demonstration (ACTD). The Air Force created mission-oriented battlelabs.

The FCT Program is managed by the Comparative Testing Office (CTO) under the Deputy Under Secretary of Defense, Advanced Systems & Concepts, Office of the Under Secretary of Defense (Acquisition, Technology & Logistics). The FCT program brings value to the acquisition process by using foreign military and commercial non-developmental items to enter the process at milestone B or C and bypass all or part of the development process. The FCT Program is authorized by Title 10, United States Code, Section 2350a(g) and funded by Office of the Secretary of Defense (OSD) Research, Development, Test and Evaluation (RDT&E) appropriations. The objectives of the FCT program, as stated in the handbook, are to improve U.S. warfighter's capabilities and reduce expenditures. The handbook provides cradle to grave instruction for an FCT and can be found at the CTO's Web site http://www.acq.osd.mil/cto.

The purpose of an ACTD is to demonstrate the effectiveness of mature or maturing technology to meet a critical user need.

Two categories of FCTs are authorized: procurement testing and technical assessment. Procurement testing focuses on finding a materiel solution for an existing requirement. Although technical assessments for the examination of potentially revolutionary foreign technologies are allowed, priority is given to projects that would result in the initiation of an acquisition. There are also two types of procurement testing: qualification and comparative testing. Qualification testing determines if a prospective system meets the stated mission requirements; while comparative testing performs side-by-side testing on multiple items that are potentially capable of meeting the requirement. If domestic items are potential candidates in the comparison test, the program sponsor must ensure funds are available to execute that portion of the test before final approval of the program as an FCT. Numerous examples of programs that have completed the FCT process are found on the CTO Web site. FCTs have led to more than $6.2 billion in procurements, saving an estimated $4.4 billion in development costs.

Advance Concept Technology Demonstration (ACTD) program is another OSD program managed by the Deputy Under Secretary of Defense for Advanced Systems and Concepts (DUSD(AS&C)). The purpose of an ACTD is to demonstrate the effectiveness of mature or maturing technology to meet a critical user need. The potential effectiveness, maturity of their respective technologies, and the user needs being met are key criteria against which candidate programs are evaluated.

Candidate technologies with a high degree of maturity and that could have revolutionary impacts on operational capabilities have an excellent chance of being selected and funded under this program.

Each ACTD is executed by a lead agency and must be sponsored by a user. The Joint Requirements Oversight Council (JROC) will review the candidate ACTDs and make recommendations concerning their selection and execution. Programs selected will nominally receive 10 to 30 percent of the ACTD's funding from OSD. Each ACTD will be executed under an oversight group, chaired by DUSD(AS&C). A major objective of the ACTD program is to transition technologies with demonstrated military utility seamlessly into acquisition programs. With the requirement for the technology to be mature, in order to qualify for an ACTD, the program should enter the traditional acquisition cycle late in the continuum and reduce the time to field the system. However, since the technology is often demonstrated on a prototype system, it is likely to need some development and less likely than an FCT to proceed directly to a milestone C decision. Examples and instructions to initiate an ACTD can be found at http://www.acq.osd.mil/actd. Current Air Force direction is under revision in a draft (AFI 10-2302), Advanced Concept Technology Demonstration.

The Air Force established its battlelab program to rapidly identify and demonstrate the military utility of innovative near-term concepts for the warfighter.

The Air Force established its battlelab program to rapidly identify and demonstrate the military utility of innovative near-term concepts for the warfighter. The Air Force stood the program up with the signing of Air Force Policy Directive (AFPD) 10-19, *Air Force Battlelab Policy*, October 1, 1997. This established the initial six battlelabs: 1) Air Expeditionary Force (AEF) Battlelab, 2) Command and Control Battlelab (C2B), 3) Force Protection Battlelab, 4) Information Warfare Battlelab, 5) Space Battlelab, and 6) Unmanned Aerial Vehicle Battlelab. A seventh, the Air Mobility Battlelab, was added later. The HQ USAF Deputy Chief of Staff (DCS) for Warfighting Integration, AF Battlelabs Innovation Division, provides overarching battlelab guidance, policy, and oversight. AFPD 10-19 (1997)established a close relationship between the battlelabs and both Air Force Research Laboratories (AFRL) and Air Force Materiel Command (AFMC) from the start. AFRL provides the battlelabs with technical expertise; demonstration facilities; data analysis; demonstration ideas; and full-time, on-site representation at the battlelabs. The battlelabs offer AFRL the opportunity to match current operational needs with existing research efforts in battlelab demonstrations. AFMC provides transitional support to both the battlelabs and AFRL, to

further expedite fielding of successful initiatives. Battlelab initiatives are funded through both procurement and operations and maintenance (O&M) funds. Again, the program is unlikely to proceed directly to a milestone C decision based on testing a prototype system. Links to all battlelabs may be found on the Space Battlelab Web site, http://www.schriever.af.mil/battlelab. For additional information, reference AFI 10-2303.

OTHER ACQUISITION TEST TOOLS

A major concern of the Air Force research laboratories is transitioning basic research into field-able systems. As a technology progresses to execution under 6.3 research funds, the laboratory is expected to demonstrate its viability in an operational significant way. This demonstration takes place in the form of critical experiments and advanced technology demonstrations (ATDs). To engender advocacy among the user and acquisition communities, laboratory program managers must encourage their participation in the planning and execution of these tests. Addressing user and acquisition concerns at this point increases the likelihood of a successful transition to an acquisition program. The identification of show stopper issues at this stage will also save the Air Force valuable research, development, test, and evaluation (RDT&E) dollars. The Air Force Chief of Staff has also established applied technology councils (ATCs) to assist in identifying funding sources for technologies that successfully complete ATDs.

Traditional T&E tools, with the adaptations made during the last decade, have proven flexible enough to address many of the requirements of the agile acquisition environment.

In addition to the fore mentioned tests, the Air Force and OSD have many on-going tests, exercises, and experiments. Each of these offers opportunities to identify new needs and examine potential solutions. Astute program managers and test directors may gain access to resources and environments that would otherwise be unavailable by participating in these tests. Exploiting them will often also save both time and money, as well as address test requirements that may be otherwise untestable. The following are a few of the major efforts and their primary purpose:

- Joint Test and Evaluation (JT&E)-numerous multi-year tests examining inter-service integration issues in designated mission areas,

- Joint Expeditionary Force Exercise (JEFX)-annual/biennial exercises focused on CSAF-directed integration issues,

- Joint Interoperability Testing (JIT)-certifies system as compliant with all joint interoperability requirements,
- Weapon Systems Evaluation Program (WSEP)-annual weapons delivery evaluations,
- Tactics Development and Evaluation (TD&E)-evaluations of specifically tasked concept of operations and development of potential alternatives, and
- Foreign Materiel Exploitation (FME)-testing of newly acquired, foreign military hardware.

SUMMARY

Traditional T&E tools, with the adaptations made during the last decade, have proven flexible enough to address many of the requirements of the agile acquisition environment. With the continued drive to improve the acquisition process, the T&E process must continue to evolve and address future acquisition innovations. The incentive evolutionary test tools bring more to the table than funding—visibility. The headquarters-level sponsorship required to become an OSD- or Air Force-level test program can carry effective systems into acquisition programs, providing the political clout necessary to find the required funding. Both the traditional and evolutionary test tools will continue to be invaluable tools in delivering operational capabilities to the warfighter. Additional insight into the scope and use of these tests may be found by referring to referenced documents and Web sites.

Gregory L. Barnette is a lead system engineer at the Enterprise Program Office in the Air Armament Center. He has 20 years of experience testing electronic warfare equipment at the Air Warfare Center and the Electronic Depot of the Air Force, where he has served as an electronics engineer, operations research analyst, test director, and chief of testing. Barnette has a bachelor's degree in electrical engineering from the University of Dayton, Dayton, OH; a master's degree in electrical engineering from the University of Florida, Gainesville, FL; and a master's degree in administration from Georgia College, Milledgeville, GA.

(E-mail address: gregory.barnette@eglin.af.mil)

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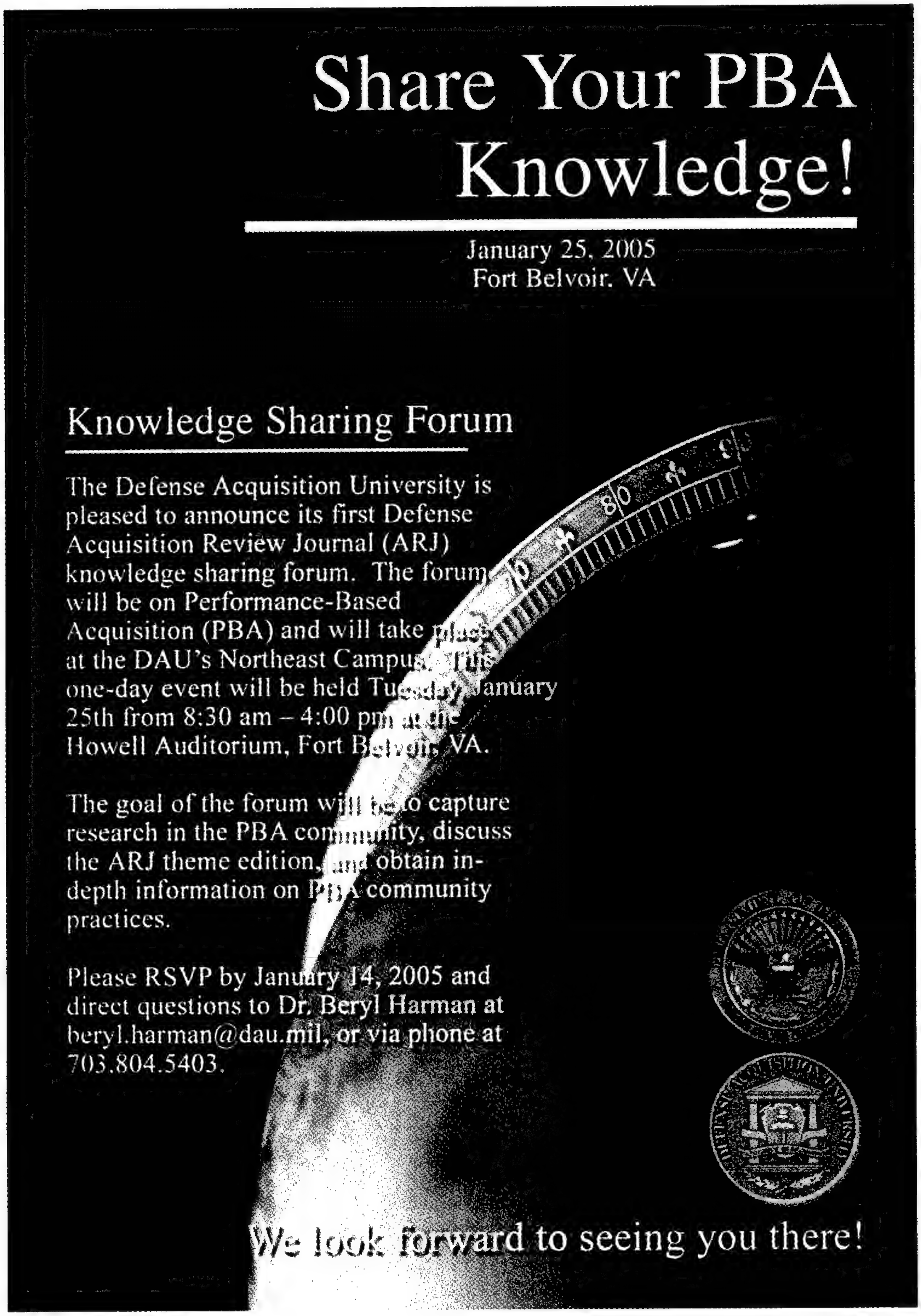
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30 December 2004	~~1 April 2005~~ 1 February 2005
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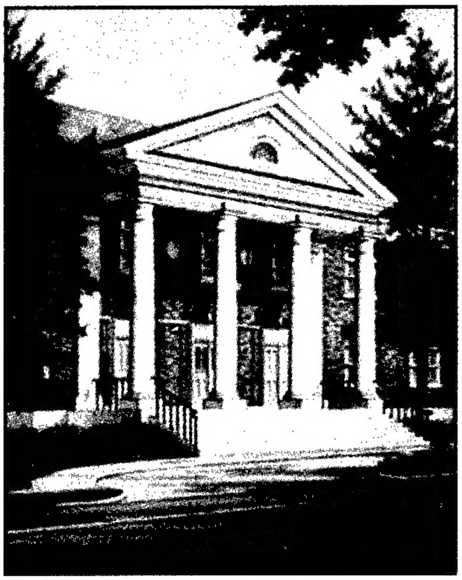

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